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Methodology for Modifying MOBILE5b in the Tier 2 Study

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1 INTRODUCTION

EPA was mandated by Congress under Section 202(l) of the Clean Air Act Amendments of 1990 to study the need for “Tier 2" emission standards for light-duty vehicles (LDVs) and light-duty trucks (LDTs) which would increase the stringency of these standards relative to the “Tier 1" standards implemented in 1994. A specifically mandated element of the Tier 2 study was that the determination of the need for new standards be based on an evaluation of air quality, along with technical feasibility and cost effectiveness. The overall focus of the air quality assessment in the study[1] is the number and population of geographic areas not in attainment with National Ambient Air Quality Standards (NAAQS) for Ozone, Carbon Monoxide and Particulate Matter currently and in the future, and the contribution of light-duty vehicular emissions to overall emission inventories. The latter element helps determine the extent to which tighter light-duty emission standards can address the air quality problem in the nation’s nonattainment areas.

The computer model MOBILE is used by EPA to estimate emission levels from on-highway mobile sources, including light-duty vehicles and trucks, heavy duty trucks, and motorcycles. MOBILE5, the current version of MOBILE, was released in 1992 with subsequent minor revisions made in 1993 (MOBILE5a) and 1996 (MOBILE5b). EPA is in the process, however, of substantially revising the MOBILE model. MOBILE6, currently scheduled for release in 1999, will include revisions to many key areas impacting tailpipe emission estimates. In particular, MOBILE6 will be updated to reflect major revisions to basic emission rates, the impacts of aggressive driving and air conditioning emissions, revised fuel sulfur impacts on newer technology vehicles, and recent trends in LDT sales and usage patterns. Because of these changes, MOBILE6 emission estimates are expected to vary considerably from those in MOBILE5.

Because the differences between MOBILE5 and MOBILE6 will affect estimates of the light-duty emission inventory, it was necessary to reflect these changes in the air quality assessment of the Tier 2 study. Unfortunately MOBILE6, even in draft form, was not available for use in the study. However, directional changes in the model are known for some of the primary components, and in some cases, data which will be used to develop the MOBILE6 emission estimates are available. In order to provide an estimate of MOBILE6 on-highway emission projections for the Tier 2 study, therefore, a “modified MOBILE5b” model was developed to serve as a surrogate for MOBILE6. This model approximated the MOBILE6 revisions planned to address basic emission rates, aggressive driving, air conditioning, fuel sulfur and fleet characteristics. This report describes how estimates were developed for these components, how the model was applied for the Tier 2 study air quality analysis, and how the modified model results compare to MOBILE5b.

[1]A detailed description of the air quality needs assessment is contained in the Tier 2 Study, Appendix A.

2 TIER 2 STUDY AIR QUALITY APPROACH

The air quality assessment performed in the Tier 2 study was based on ozone modeling performed as part of the Ozone Transport Assessment Group (OTAG) modeling process. In OTAG, ozone projections for calender year 2007 under several control scenarios were developed on a regional basis (by county or grid) over the entire 37 state OTAG region, enabling an evaluation of ozone nonattainment areas which would result under each scenario. This work was useful for the Tier 2 assessment since it projected future ozone nonattainment under a variety of control scenarios. In particular, one scenario referred to as "Round 2 Run 5" closely simulates the regional NOx control strategy proposed in the OTAG SIP Call NPRM, in addition to controls for other sources at Clean Air Act mandated levels and other existing controls. This run used a set of mobile sources control programs known as "Level 0", which included National LEV (NLEV), Inspection/Maintenance (I/M), Reformulated Gasoline (RFG), and new heavy-duty standards[2].

In the Tier 2 study, Round 2 Run 5 results for all sources other than on-highway were used in conjunction with modified MOBILE5b on-highway inventory results. This allowed a revised assessment of LDV and LDT contribution to overall inventory under existing controls[3]. The Tier 2 analysis focused on four basic combinations of on-highway mobile source control programs (example cities/areas are shown in parenthesis):

a. Ozone Transport Region (OTR) NLEV with I/M and RFG (Northeast)
b. Non-OTR NLEV with I/M and RFG (Chicago)
c. Non-OTR NLEV with I/M and no RFG (Atlanta/Charlotte)
d. Non-OTR NLEV without I/M or RFG (Attainment)

The goal of the analysis presented in this report was to replicate as closely as possible the OTAG "Level 0" control program using both MOBILE5b and the modified MOBILE5b model in order to a) develop the revised Round 2 Run 5 on-highway mobile source estimates results for use in the Tier 2 air quality analysis, and b) provide a basis for comparison between the two models.

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[2]E.H. Pechan & Associates, Inc., "Ozone Transport Assessment Group Emissions Inventory Development Report, Volume 3: Projections and Controls". All OTAG program details and emission factors used in this analysis are from this report.

[3]MOBILE5a was used for OTAG, while MOBILE5b was used for this analysis. Use of the latest release of MOBILE5 was judged appropriate, and differences between the two models are not significant for the purpose of this work.

3 DEVELOPMENT OF MODIFIED MOBILE5b INPUTS

3.1 Basic Emission Rates

Basic Emission Rates, or "BERs", are rates used by the MOBILE model to predict emission levels from in-use vehicles over the Federal Test Procedure (FTP). BERs are established for each vehicle class and model year to account for differences in emission standards and technologies. To account for the impacts of deterioration as vehicles grow older, MOBILE BERs are comprised of a baseline constant known as a "zero-mile level" (ZML) and a "deterioration rate" (DR), which is a function of vehicle mileage. The BER is calculated by multiplying the DR by mileage and adding the result to the ZML. The BER is then adjusted as appropriate to account for numerous factors including speed, temperature and fuel properties, as well as benefits from control programs such as I/M.

For the non-I/M case, BERs for Tier 0 light-duty vehicles proposed for MOBILE6 are substantially lower than those for MOBILE5b, particularly at higher mileages[4]. In large part this is due to the elimination of the "kinked" deterioration rate at 50,000 miles, which resulted in significant increases in MOBILE5b emission estimates for vehicles above this mileage level. MOBILE6 emission rates for Tier 1 and Low Emission Vehicles (LEVs) have not been developed, but non-I/M rates for these vehicles will also likely be significantly lower than MOBILE5b. Because the MOBILE6 BERs are still under development, the new rates were estimated beginning in the 1988 model year using emission rates from the California Air Resources Board's CALIMFAC model [5]. The CALIMFAC rates are significantly lower than the MOBILE5b rates, and directionally capture the decrease expected to occur between MOBILE5b non-I/M rates and MOBILE6. As a general comparison, 1992 model year LDV non-I/M CALIMFAC rates are shown with corresponding rates from MOBILE5b in Figures 1-3 for HC, CO and NOx. CALIMFAC's "LDV" rates were used for LDVs. CALIMFAC's "LDT" category includes all trucks below 6,000 pounds GVW, and were thus used for the MOBILE LDT1 (MOBLDT1) class [6]. The CALIMFAC MDV class includes trucks between 6,000 and 14,000 pounds, but is comprised primarily of those below 8,500 pounds, and were thus used directly for MOBLDT2s.

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[4]"Composite Exhaust Emissions", EPA presentation at the October 1997 MOBILE6 workshop.

[5]Revised BERs were implemented beginning in 1988 because of uncertainty at the time of this analysis as to how early MOBILE5b BERs would be revised.

[6]The acronyms "MOBLDT1" and "MOBLDT2" are used in this report to denote the MOBILE5b trucks definitions, and avoid confusion with the certification definitions. MOBLDT1s are trucks below 6,000 lbs GVW (which encompass certification LDT1s and 2s), while MOBLDT2s are trucks above this threshold (encompassing certification LDT3s and 4s).

Figure 1 - HC Basic Emission Rates: MOBILE5b vs. CALIMFAC (no I/M)

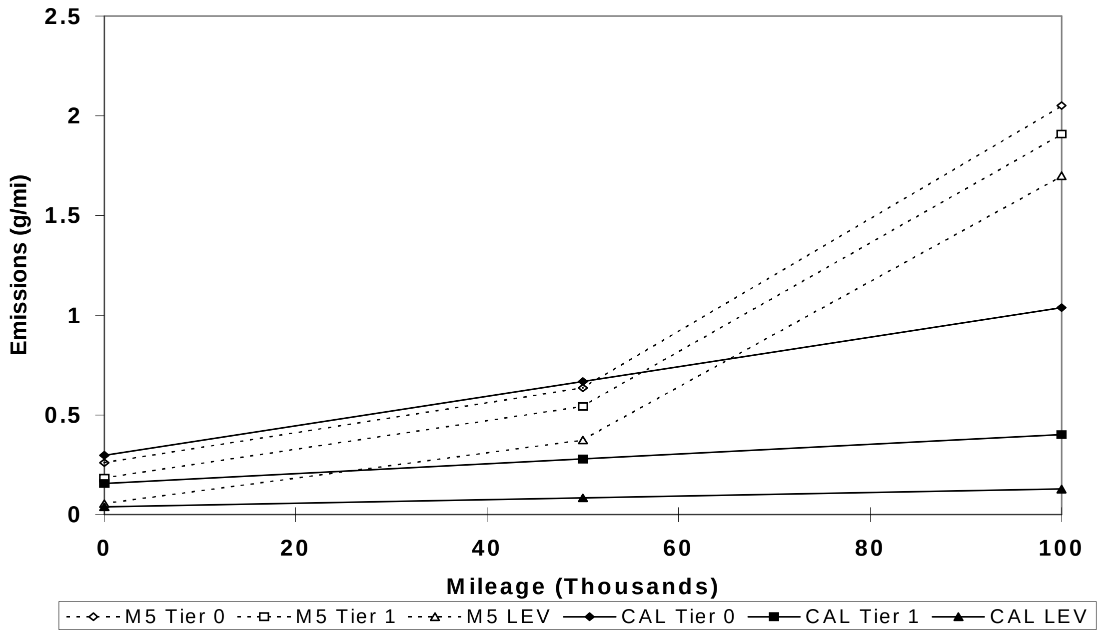


Figure 2 - CO Basic Emission Rates: MOBILE5b vs. CALIMFAC (no I/M)

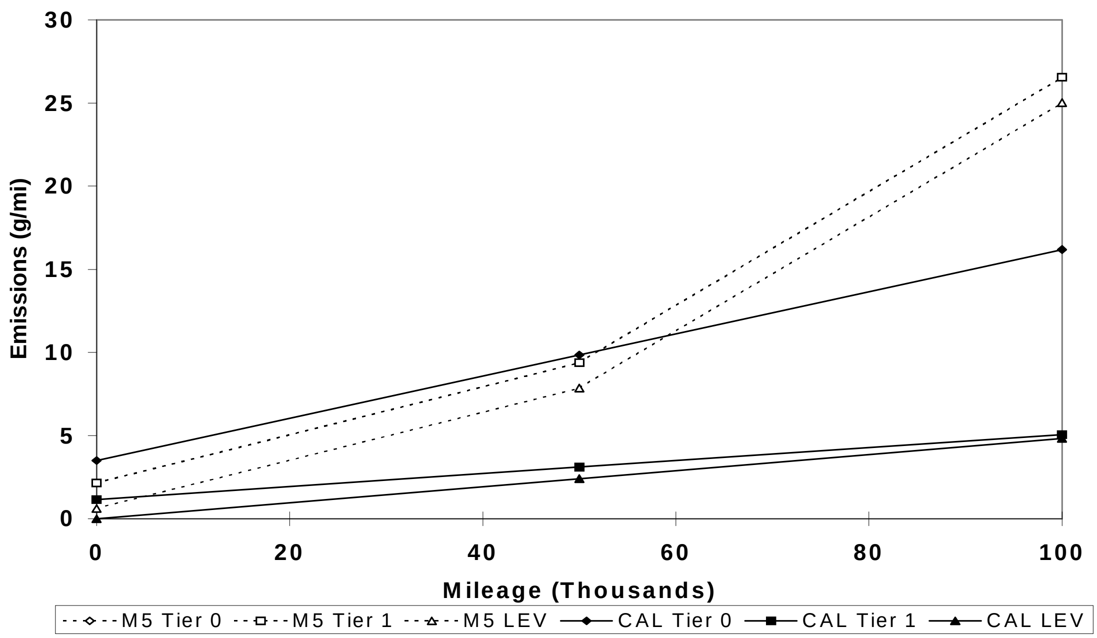
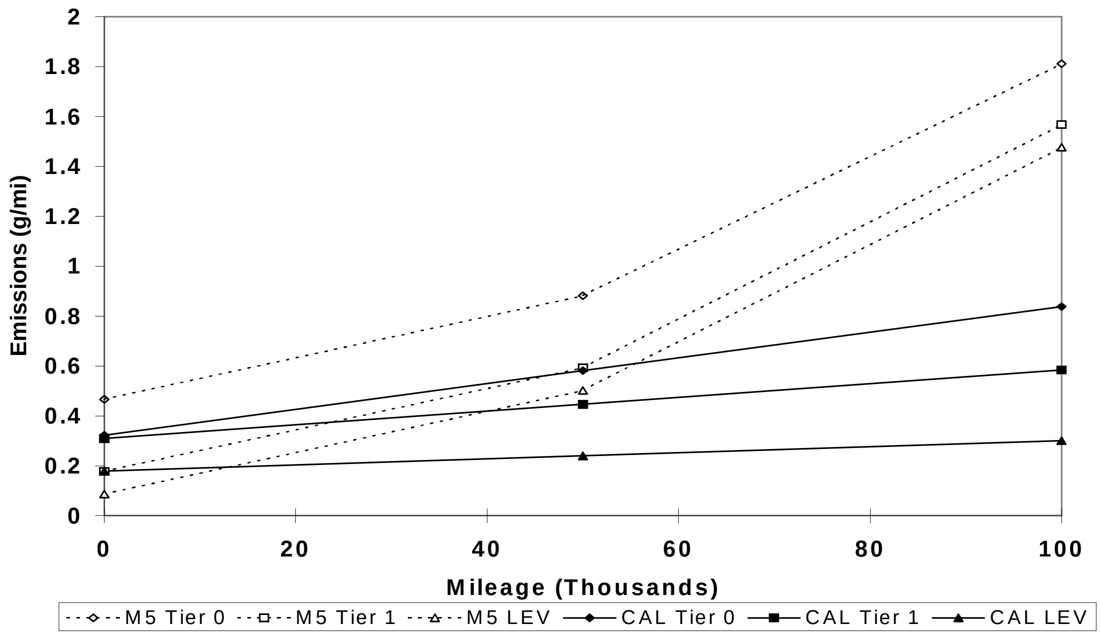


Figure 3 - NOx Basic Emission Rates: MOBILE5b vs. CALIMFAC (no I/M)



Modeling of an I/M program in MOBILE5b can significantly vary the basic emission rates used by the model. All I/M programs for Tier 0 and Tier 1 light-duty vehicles are based on "kinked" baseline emission rates, and thus also result in higher "with I/M" emission levels than expected in MOBILE6. However, for LEVs, application of maximum I/M in MOBILE5b (as used in OTAG) results in substantial emission reductions from the non-I/M case. Thus, for future calender years in which the fleet is comprised primarily of LEVs, it is not certain that MOBILE6 will result in lower emission levels than would be predicted with MOBILE5b when maximum I/M is modeled. MOBILE6 I/M credits are currently under development, so a direct assessment of these differences is not yet possible.

MOBILE5b I/M credits were developed based on the MOBILE5b emission rates, and cannot appropriately be applied to the CALIMFAC non-I/M rates. Therefore, I/M benefits were handled in the modified model by using the CALIMFAC "with I/M" emission rates (a more detailed discussion of I/M program treatment is contained in Section 4.1). These rates reflect the benefits of a dynamometer-based program, judged for the purposes of this analysis to be a reasonable approximation of the "high enhanced" I/M program modeled under OTAG. The CALIMFAC I/M rates also include the full effects of On-Board Diagnostics (OBD II) as appropriate by vehicle class and model year, an element that will be incorporated into MOBILE6 as well. In general the CALIMFAC "with I/M" DRs are approximately 30-40% lower than the CALIMFAC non-I/M DRs (the ZMLs are the same for both cases).

CALIMFAC rates could not be used directly beyond 1992 because of differences between the California and Federal light-duty programs. California Tier 1 standards began phase-in in 1993, while the Federal program did not start until 1994; in addition, the NLEV programs modeled for both the OTR and Non-OTR scenarios do not correspond with California's LEV phase-in plan. By-model year emission rates were therefore developed for 1993 and later by combining CALIMFAC rates according to the applicable Federal Tier 1 and NLEV phase-in schedules. This methodology required the estimation of "base" CALIMFAC Tier 0, Tier 1, TLEV and LEV emission rates to allow proper combinations of standard level in each model year. The CALIMFAC 1992 rates were used for base Tier 0, while base Tier 1 and LEV rates were extracted from the CALIMFAC model[7]. TLEV rates were then estimated by interpolating the Tier 1 and LEV rates based on the certification standards (this affected HC only, since TLEV CO and NOx standards are unchanged from Tier 1). The estimated "with I/M" base emission rates for each standard level are shown in Table 1.

Table 1 - Estimated "With I/M" CALIMFAC Emission Rates - Grams/Mile

		HC		CO		NOx	
		ZML	**DR**	**ZML**	**DR**	**ZML**	**DR**
LDV	**Tier 0**	0.2980	0.0350	3.5112	0.5708	0.3227	0.0224
	Tier 1	0.1569	0.0142	1.1609	0.2438	0.3091	0.0188
	TLEV	0.0729	0.0078	1.1609	0.2438	0.3091	0.0188
	LEV	0.0393	0.0052	0.0000	0.2797	0.1790	0.0081
LDT	**Tier 0**	0.2961	0.0373	3.4550	0.6370	0.5641	0.0422
	Tier 1	0.1440	0.0161	1.0613	0.2614	0.3009	0.0205
	TLEV	0.0588	0.0071	1.0613	0.2614	0.3009	0.0205
	LEV	0.0247	0.0035	0.0000	0.1787	0.2980	0.0150
MDV	**Tier 0**	0.3001	0.0309	3.6745	1.1094	0.7838	0.0499
	Tier 1	0.1402	0.0160	0.9732	0.2634	0.2976	0.0202

For LDVs and MOBLDT1s, the Tier 1 phase-in schedule is 40% in 1994, 80% in 1995 and 100% in 1996. For MOBLDT2s, the schedule is 50% in 1996 and 100% in 1997. For NLEV, which applies only to LDVs and MOBLDT1s, the appropriate phase-in of TLEV and LEVs depended on whether the area being modeled was inside the OTR or not. Phase-in schedules for OTR and non-OTR cases were duplicated from OTAG's Level 0 control package, and are shown in Table 2. For both the Tier 1 and NLEV phase-in periods, BERs for a given model year were developed by combining the base BERs from Table 1 using the phase-in weighting; for example, 1994 LDV rates were developed by combining base Tier 0 and Tier 1 rates using a 60/40 weighting. The resulting base light-duty BERs for the Northeast and Attainment cases are shown in Appendix A.

[7]This work was performed by Air Improvement Resource (AIR), Inc. under contract by AAMA. The base rates mentioned were provided by AIR to EPA for the purpose of this analysis.

Table 2 - NLEV Phase-In Percentages Used in OTAG Modeling (LDV & MOBLDT1)					
Model Year	**Ozone Transport Region (OTR)**			**Non-OTR**	
	Tier 1	**TLEV**	**LEV**	**Tier 1**	**LEV**
1996	100	0	0	100	0
1997	60	40	0	100	0
1998	60	40	0	100	0
1999	30	40	30	100	0
2000	0	40	60	100	0
2001 & later	0	0	100	0	100

OTAG's Level 0 control package included alternate heavy-duty BERs which modeled the new 2.5 gram/bhp-hour NMHC+NOx standard. For consistency with the OTAG work, these BERs were used for both MOBILE5b and the modified model. The revised rates, implemented starting in 2004, are shown in Table 3.

Table 3 - Heavy Duty Basic Emission Rates Used in OTAG Modeling			
Vehicle Type	**Pollutan**	**ZML (grams/BHP-hr)**	**DR (grams/BHP-hr/10,000**
HD Gas (HDGV)	NOx	1.660	0.021
HD Diesel	NOx	1.840	0.000
HD Gas	HC	0.277	0.018
HD Diesel	HC	0.257	0.000

3.2 Off-Cycle

Off-cycle correction factors used in the modified MOBILE5b model incorporated the effects of uncontrolled aggressive driving and air conditioner operation, as well as the impact of the Supplemental Federal Test Procedure (SFTP) requirements recently promulgated by EPA and ARB[8]. EPA's rule applies to Tier 1 vehicles, and begins phase-in in 2000. ARB's rule applies primarily to LEV/ULEVs, and begins phase-in in 2001. Both rules will dramatically reduce uncontrolled off-cycle emissions, and will be accounted for in MOBILE6. However, under NLEV, the ARB standards and phase-in will supersede the EPA rule, so treatment of benefits from the ARB rule are of primary importance. The development of uncontrolled and controlled aggressive driving and air conditioning correction factors are discussed in the following sections.

[8]EPA: "Motor Vehicle Emissions Federal Test Procedure Revisions; Final Regulations", 61 FR 54851 October 22, 1996. ARB: "Public Hearing to Consider Adoption of New Certification Tests and Standards to Control Exhaust Emissions from Aggressive Driving and Air-Conditioner Usage for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles Under 8,501 Pounds Gross Vehicle Weight Rating", Staff Report, July 1997.

3.2.1 Aggressive Driving

3.2.1.1 Uncontrolled Aggressive Driving

MOBILE6 will incorporate aggressive driving (i.e. driving at higher speeds and/or higher acceleration rates than found on the conventional FTP) using speed correction factors based on roadway type. MOBILE6's running basic emission rates (represented by the “running LA4", developed to represent baseline running emission rates[9]) will be adjusted for each pollutant using corrections developed separately for three fundamental roadway types: Freeway, Arterial and Local. As planned, the MOBILE6 user will have the ability to specify combinations of roadway type (expressed in terms of weightings for vehicle miles traveled, or VMT) and the speed distribution on some roadway types to allow customized scenario modeling. In the absence of such data, MOBILE6 will use default roadway and speed weightings developed from national average information. Thus, the default aggressive driving corrections in MOBILE6 will reflect a representative weighting of both roadway type and speed.

MOBILE6 roadway-based VMT and speed correction information were not available for this analysis. As a surrogate, the modified MOBILE5b correction factors were based on results from California’s “Unified” Cycle (LA92). This cycle was developed by ARB to reflect a representative weighting of in-use speed and acceleration distributions based on driving patterns observed in Los Angeles. The cycle, therefore, is similar in concept to the default weightings which will be used in MOBILE6, and is considered a reasonable approximation of the MOBILE6 aggressive driving approach.

The LA92 data used for this analysis were gathered on the same vehicle sample which will be used to develop the MOBILE6 correction factors. The cycle was run with the vehicle warmed up (i.e. without starts or soaks), so a direct comparison between the LA92 and running LA4 is consistent with the handling of running aggressive driving correction factors in MOBILE6. Running correction factors were developed by taking the ratio of sample average LA92 results to sample average running LA4 results. Performing this analysis by certification standard (Tier 0 vs. Tier 1) on normal emitters[10] indicated that the factors for Tier 1 vehicles are higher than the factors for Tier 0 vehicles for each pollutant. This difference was judged to be appropriate due to the nature of off-cycle emissions relative to FTP performance. Vehicles complying with Tier 1 standards are optimized for compliance with the conventional FTP. Although it is likely that

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[9]“Running LA4" emissions were derived from the combination of emissions from Bag 2 and a 505 cycle run warmed-up (i.e. without a soak). In MOBILE6, start and running emission will be treated separately, with the running LA4 serving as the base running emission cycle to which speed correction factors are applied. More detail on this can be found in MOBILE6 Report No. M6.STE.002, “The Determination of Hot Running Emissions from FTP Bag Emissions".

[10]A “normal” emitter is defined under comparable MOBILE6 analyses as having Running LA4 emissions under 0.8 g/mi for HC, 15.0 for CO and 2.0 for NOx. These cutpoints are applied independently, so a vehicle could be a normal emitter for one pollutant and a high emitter for another.

some benefit from reductions over the conventional FTP will carry over to off-cycle emissions, the same relative magnitude of reduction is not expected to carry over. For example, catalyst sizing and loading are determined by emission performance over the FTP; these may increase for Tier 1 compliance, resulting in some benefit off-cycle as well. However, because of the focus on FTP performance, catalyst breakthrough off-cycle will occur on Tier 1 vehicles as with Tier 0 vehicles. Although lower than Tier 0 off-cycle emissions, the decrease in off-cycle emissions on Tier 1 vehicles will not be of the same percentage as the decrease in FTP running emissions. This would result in a larger aggressive driving correction on Tier 1 vehicles than for Tier 0 vehicles.

Tier 0 emission factors were generated based on certified Tier 0 normal emitters in the sample (48 vehicles for HC, 57 for CO and 59 for NOx). Since only 12 Tier 1 vehicles were tested, an attempt was made to increase the robustness of the Tier 1 sample by adding Tier 0 vehicles which were considered equivalent to Tier 1 vehicles. Nine Tier 0 vehicles whose LA92 NMHC and NOx emissions were at or below 70% of the Tier 1 FTP standard[11] were added to the certified Tier 1 vehicle sample, creating a sample of 21 vehicles from which the final Tier 1 corrections were generated. The Tier 1 correction factors were also applied to LEVs since data necessary to develop independent LEV correction factors is not available. The resulting running correction factors for uncontrolled aggressive driving are shown in Table 4.

3.2.1.2 Post-SFTP Aggressive Driving

The impact of ARB's LEV SFTP rule was of primary importance for this analysis, since under NLEV LDVs and MOBLDT1s will be subjected to this requirement. For this analysis, however, LEV benefits were based on reductions claimed by EPA for Tier 1 vehicles, so treatment of Tier 1 vehicles was first required. In EPA’s SFTP rule, benefits for Tier 1 vehicles were estimated based on a reduction in the incremental emission increase between overall in-use running operation (based on a weighting of representative inventory cycles) and warmed-up FTP conditions (represented by a running LA4) of 88% for NMHC, 72% for CO and 78% for NOx[12]. The uncontrolled correction factors developed for the modified model using the LA92 and running LA4 attempt to quantify the incremental increase in emissions due to aggressive driving in a similar manner as the SFTP rule. Thus, SFTP benefits in the modified model were developed for Tier 1 vehicles by applying the percent reductions from the SFTP rule to the uncontrolled correction factors developed in the previous section. SFTP-controlled aggressive driving correction factors for LEVs were developed by adjusting the Tier 1 reductions according to the estimated stringency of ARB’s US06 standards relative to EPA’s standards, as detailed in

[11] Performing this analysis using Tier 0 vehicles whose FTP levels were below 70% of the Tier 1 FTP NMHC and NOx standards reduced the Tier 1 NMHC correction by 5% relative to the LA92-based corrections, increased the NOx correction factor by 15% and did not change the CO correction factor. The FTP-based approach is judged to be more technically correct than the LA92 approach and will be used for future analyses.

[12] "Response to Comments for the Final Regulations to the Federal Test Procedure for Emissions from Motor Vehicles”, EPA Docket A-92-64 Item 5-C-1. Hereafter referred to as “SFTP Response to Comments”.

Appendix B. The SFTP-controlled aggressive driving correction factors for both Tier 1 vehicles (pertinent for MOBLDT2s) and LEVs are shown in Table 4.

Table 4 - Aggressive Driving Correction Factors (Running Only)

Standard Level	HC*		CO		NOx	
	Pre-SFTP	Post-SFTP	Pre-SFTP	Post-SFTP	Pre-SFTP	Post-SFTP
Tier 0	1.40	n/a	1.88	n/a	1.57	n/a
Tier 1	2.40	1.17	2.52	1.43	1.63	1.14
LEV	2.40	1.06	2.52	1.44	1.63	1.04

*** THC for Tier 0, NMHC for Tier 1 / LEV**

3.2.2 Air Conditioning

3.2.2.1 Uncontrolled Air Conditioning

As proposed, running air conditioning correction factors in MOBILE6 will follow a similar approach as the aggressive driving corrections. The model will rely on speed-based correction factors for each pollutant to develop overall "full-usage" factors (meant to represent air conditioning emissions when the A/C system is fully loaded) using the default or user-supplied speed distribution. The base correction factor will then be scaled down to reflect more representative ambient conditions. The scaled-down air conditioning correction factor will then be applied to the non-air conditioning emission level, including the effects of aggressive driving. Unlike aggressive driving, air conditioning correction factors will also be developed for starts[13].

The proposed MOBILE6 factors were not available for this analysis. Given the approach for MOBILE6, the LA92 cycle was again judged appropriate to develop running air conditioning correction factors for the modified model. A/C-on emission data over the LA92 was collected over all vehicles from which the MOBILE6 corrections will be generated. Full-usage correction factors were generated for each pollutant by dividing the sample average A/C-on results by the sample average A/C-off results. Separate factors were generated for LDVs and LDTs (as is proposed for MOBILE6) to account for differences in relative loading placed on cars and trucks by the A/C system. Start emission factors were generated separately for LDVs and LDTs using the ratio of cold start ST01 emissions.

For consistency with MOBILE6, the full-usage correction factors must be scaled down to reflect more representative ambient conditions. The full-usage factors derived above were therefore multiplied by a factor of 0.52 to represent the fraction of time that the A/C compressor is engaged

[13]The proposed MOBILE6 air conditioning activity levels and correction factors can be found in two reports: "Air Conditioning Activity Effects in MOBILE6", MOBILE6 Report No. M6.ACE.001, and "Air Conditioning Correction Factors in MOBILE6", MOBILE6 Report No. M6.ACE.002.

on a typical ozone exceedance day. This factor was developed as part of the SFTP rulemaking based on temperature and humidity levels for typical ozone days cross-referenced with available air conditioning activity data[14]. The resultant "typical" corrections are shown in Table 5.

3.2.2.2 Post-SFTP Air Conditioning

Estimates for the effect of SFTP control on air conditioning emissions were also based on EPA's SFTP rule, and LEV benefits were again developed separately from Tier 1 benefits. In EPA's rule, the NOx air conditioning standards for SC03 (the control cycle used for air conditioning certification) were developed based on control of approximately 50% of the incremental emissions due to air conditioner operation[15]. For the modified model it was assumed that this reduction can be applied over the entire range of warmed-up driving, and the post-SFTP NOx running correction factors were developed by reducing the uncontrolled corrections by 50%. For start emissions, it was assumed that the SFTP rule would have no impact on uncontrolled emissions, since control of A/C emissions was primarily ascribed to catalyst conversion efficiency and EGR, both of which are not factors during cold starts. Therefore, post-SFTP start A/C corrections were not changed for the uncontrolled corrections.

NMHC and CO emissions were also treated in accordance with EPA's SFTP rule. In cases where NMHC emissions increased due to air conditioner operation, the SFTP-controlled correction factors were set to 1.0 under the assumption that excess fuel enrichment will be eliminated on SFTP-compliant vehicles. If uncontrolled NMHC emissions were less than 1.0, they were left unchanged (a reduction of HC emissions under A/C operation is frequently observed, and is attributed to increased combustion temperature resulting from the added engine load). The elimination of commanded enrichment expected under the SFTP rule was also assumed to reduce uncontrolled CO emissions. However, because unavoidable loading increases will still result in increased fuel consumption, the controlled CO correction factor was not reduced to 1.0 but was instead equated with the increase in CO_2 emissions (approximately 20%), as planned for MOBILE6.

SFTP-controlled NOx correction factors for LEVs were developed according to the estimated stringency of ARB's air conditioning (SC03) standards relative to EPA's standards, as detailed in Appendix B. The controlled NMHC and CO factors for Tier 1 vehicles were applied to LEVs, since the ARB and EPA requirements are similar in their intent to eliminate excess A/C enrichment. The resultant correction factors for post-SFTP Tier 1 vehicles and LEVs are shown in Table 5.

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[14]SFTP Response to Comments

[15]SFTP Response to Comments. It should be noted that the 50% percent reduction is based on a baseline emission increase of 100%, a much higher increase then seen over the LA92 sample used for this analysis. The technical basis for the standard is in fact to allow an increase of 50% from A/C off levels, which would result in a higher emission level than reflected by the post-SFTP estimates for this analysis. This issue will be reevaluated in the development of MOBILE6.

Table 5 - Air Conditioning Correction Factors ("Typical" Conditions)							
Vehicle	**Standard**	**HC***		**CO**		**NOx**	
		Pre-SFTP	Post-SFTP	Pre-SFTP	Post-SFTP	Pre-SFTP	Post-SFTP
		Running					
LDV**	**Tier 0**	1.09	n/a	1.48	n/a	1.17	n/a
	Tier 1	1.10	1.00	1.48	1.10	1.17	1.09
	LEV	1.10	1.00	1.48	1.10	1.17	1.08
LDT	**Tier 0**	0.97	n/a	1.28	1.10	1.14	n/a
	Tier 1	0.96	0.96	1.28	1.10	1.14	1.07
	LEV	0.96	0.96	1.28	1.10	1.14	1.02
		Start					
LDV	**Tier 0**	0.98	0.98	0.97	0.97	1.14	1.14
	Tier 1	0.98	0.98	0.97	0.97	1.14	1.14
	LEV	0.98	0.98	0.97	0.97	1.14	1.14
LDT	**Tier 0**	1.02	1.02	1.09	1.09	1.10	1.10
	Tier 1	1.02	1.02	1.09	1.09	1.10	1.10
	LEV	1.02	1.02	1.09	1.09	1.10	1.10
* THC for Tier 0, NMHC for Tier 1 / LEV ** LDV also applies to Certification LDT1s (< 3750 lb)							

3.2.3 Final Off-Cycle Corrections

For the modified MOBILE5b model, aggressive driving and air conditioning corrections were combined into a single "off-cycle" correction which was applied directly to the basic emission rates discussed in Section 3.1. Development of the appropriate off-cycle corrections required the combination of the aggressive driving and air conditioning factors and the translation of the running and start-based factors into a combined FTP-based factor.

Since the running air conditioning correction factors represent the incremental increase of emissions over all warmed-up driving as represented by the LA92 (the basis for aggressive driving factors), combined off-cycle running factors were developed by multiplying the aggressive driving and air conditioning running factors (from Tables 4 and 5) together. Since only air conditioning also had start factors, these factors were carried over as the "combined" off-cycle start factors. In order to convert the combined correction factors into the MOBILE5b definition of trucks, MOBLDT1 factors were developed by combining the "LDV/Certification LDT1" and "LDT" corrections together based on a 30/70 weighting (this split was used in the development of CALIMFAC "LDT" emission rates). The "LDT" corrections were applied directly for MOBLDT2s.

The start and running off-cycle factors were then combined into an FTP-based factor using the running/FTP fractions developed for the proposed MOBILE6 Tier 0 1990-93 PFI LDV BERs (see reference note 4). Since these splits are dependent on vehicle mileage, estimates of the average in-use mileage for LDVs (68K miles), LDT1s (81K miles) and LDT2s (100K miles) were used to establish the appropriate splits (the development of these average mileage levels is discussed in Section 3.4.3). The combined start and running off-cycle factors were weighted with the appropriate split (start fraction = 1 - running fraction) to derive the FTP-based off-cycle correction factors. The running/FTP fractions are shown in Table 6, and the final FTP-based off-cycle correction factors are shown in Table 7.

Table 6 - Running / FTP Fractions

Vehicle Class	Mileage	HC Fraction	CO Fraction	NOx Fraction
LDV	68,000	0.48	0.70	0.80
MOBLDT1	81,000	0.51	0.74	0.82
MOBLDT2	100,000	0.55	0.77	0.84

Table 7 - Final FTP-Based Off-Cycle Correction Factors

Vehicle	Standard	HC*		CO		NOx	
		Pre-SFTP	Post-SFTP	Pre-SFTP	Post-SFTP	Pre-SFTP	Post-SFTP
LDV	**Tier 0**	1.24	n/a	2.24	n/a	1.70	n/a
	Tier 1	1.78	1.07	2.90	1.39	1.75	1.22
	LEV	1.78	1.02	2.90	1.40	1.75	1.13
MOBLDT1	**Tier 0**	1.21	n/a	2.14	n/a	1.68	n/a
	Tier 1	1.72	1.07	2.77	1.43	1.74	1.20
	LEV	1.72	1.03	2.77	1.46	1.74	1.11
MOBLDT2	**Tier 0**	1.21	n/a	2.10	n/a	1.68	n/a
	Tier 1	1.73	1.08	2.73	1.46	1.74	1.20
	LEV	1.73	1.04	2.73	1.48	1.74	1.10

* THC for Tier 0, NMHC for Tier 1 / LEV

Off-cycle correction factors were applied on a by-model year basis to account for Tier 1 phase-in (since Tier 0 and Tier 1 corrections were different), and phase-in of the SFTP requirement. Composite off-cycle corrections during the Tier 1 phase-in period were handled by weighting Tier 0 and Tier 1 correction factors using the appropriate phase-in schedule. Since NLEV was modeled in all cases, ARB's SFTP phase-in schedules were applied to LDVs and MOBLDT1s (25/50/85/100% starting in 2001), while EPA's phase-in was applied to MOBLDT2s

(40/80/100% starting in 2002). Prior to the first year of applicable SFTP phase-in, the uncontrolled correction factors were applied. During phase-in, the uncontrolled and controlled off-cycle corrections were weighted according to the appropriate percentage in each year. The controlled factors were applied to the first year of 100% compliance and afterwards. The resultant off-cycle corrections were applied to the BERs (both the zero-mile level and deterioration rates) starting from 1983 onward. 1983 was chosen as the first year of off-cycle correction primarily because it was the oldest model year in the calender year 2007 scenarios; application of the Tier 0 off-cycle corrections was judged appropriate this far back because three-way catalyst technology was predominant in the light-duty fleet.

3.3 Fuel Effects

Data recently gathered on the impacts of fuel sulfur on LEV emissions indicates that as sulfur levels increase, emissions increase much more than projected by MOBILE5b. Sulfur corrections for all vehicles are being revised for MOBILE6. Because the most significant change will occur with LEVs, the modified MOBILE5b model incorporated estimates only for LEVs based on the new data. The following sections describe available emission data on the effect of sulfur on LEV emissions, EPA's analyses of these data, and how the results of this analysis were incorporated into the modified MOBILE5b model.

3.3.1 Sulfur Test Programs

Two test programs were recently performed to assess the impact of fuel sulfur on LEV emissions. One was performed by the Coordinating Research Council (CRC), made up of selected automotive and oil companies, and the other was performed by automobile manufacturers who are members of the American Automobile Manufacturers Association (AAMA) and the Association of International Automobile Manufacturers (AIAM). The CRC study involved six LDV models certified for sale in California in 1997. Two vehicles from each model type were tested on seven fuels: California RFG with 40 ppm sulfur, California RFG doped to 150 ppm sulfur, and national average conventional gasolines with doped sulfur levels of 40, 100, 150, 330, and 600 ppm. The vehicles were leased from rental companies and averaged approximately 10,000 miles of use. The vehicles were tested in an as-received condition and with catalysts and oxygen sensors aged to 100,000 miles. All testing was conducted at a single laboratory.

The AAMA/AIAM study consisted of 21 vehicles, each of different design: 13 LEV LDVs, one LEV LDT1 (using the certification definition), six LEV LDT2s, one LEV MDV2 (LDT3), and four ULEV LDVs. Some of the vehicle designs had been certified for sale in California, while other design were deemed ready for certification and production. Each vehicle was tested by its own manufacturer in order to maintain confidentiality. The resulting data was provided to an independent statistician, who compiled the data. Five fuels were tested: the base fuel was a California RFG with 40 ppm sulfur, and the other four fuels used the California RFG fuel doped to 100, 150, 330, and 600 ppm. Figures 4 and 5 show average LDV NOx and NMHC emission levels for both programs.

Figure 4 - Average LDV NOx Emissions from LEV Sulfur Test Programs

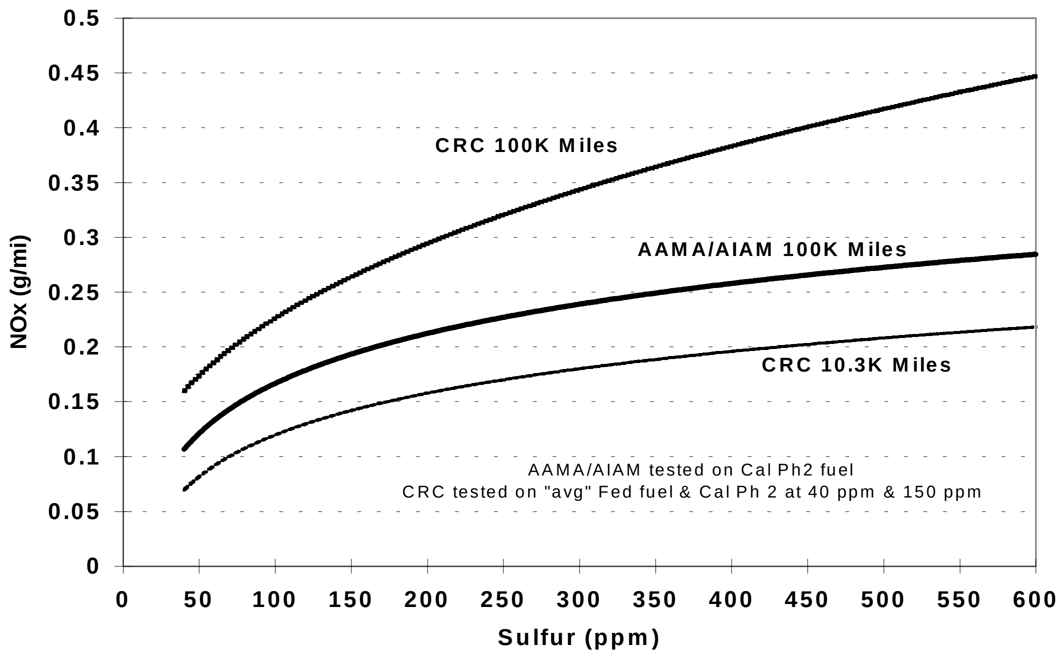
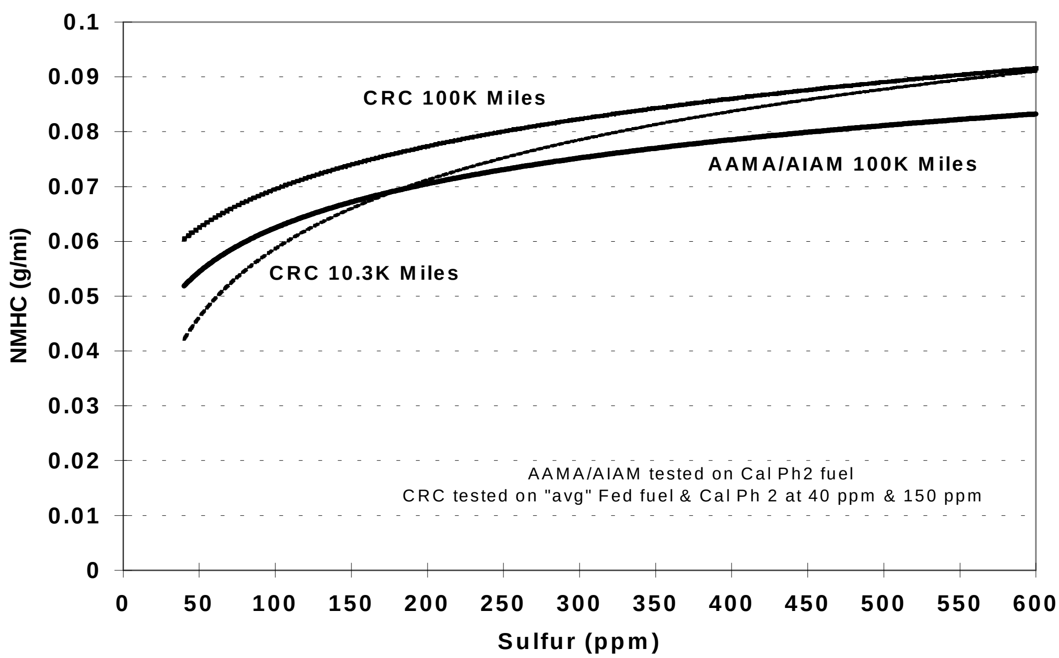


Figure 5 - Average NMHC Emissions from LEV Sulfur Test Programs



3.3.2 LEV Correction Factors

For the modified MOBILE5b model, correction factors for all pollutants were develop based on the percentage increase from 40 ppm to 150 ppm (approximated Phase 2 RFG sulfur level) and 339 ppm (industry average non-RFG level as estimated by MOBILE5) from the CRC and AAMA/AIAM data. This required several steps starting from the raw test results from both programs. The first step was to perform regressions of the emissions of each pollutant from all the vehicles (separately for LDV/LDT1s and LDT2/3s) at the same mileage and test program versus sulfur level. Thus, for both vehicle classes, nine regressions were performed in all; three for each pollutant, and three for each mileage/test program combination (CRC low and high mileage, AAMA/AIAM high mileage). In each regression, each vehicle was assigned a dummy variable to account for differences in their low-sulfur emission rates. The fitting of emission versus sulfur depended on which form provided the greatest degree of correlation. For the CRC low mileage data, the logarithm of emissions were regressed against sulfur. For the two high-mileage cases, the logarithm of emissions were regressed against the logarithm of sulfur. Only the CRC emission data using the Federal national average base fuel were included in the regressions of the CRC data, in order to avoid the confounding effects of non-sulfur related differences between the national average fuel and the Phase 2 California RFG fuel in the CRC testing.

The next step was to account for mileage. As discussed in Section 3.4.3, the average in-use mileages for LDVs, MOBLDT1s and MOBLDT2s were estimated for this analysis to be 68K, 81K and 100K miles. The absolute emissions at each tested sulfur level were determined from the two CRC regressions for each pollutant (low and high mileage). The emissions at the two mileage points were then interpolated to estimate CRC-based emissions at the average in-use mileages for LDVs, MOBLDT1s and MOBLDT2s. The ratio of emissions at the average in-use mileages to those at 100K miles were then determined for each sulfur level, pollutant and vehicle type. These ratios were then applied to the 100K emission data from the AAMA/AIAM test program to produce estimated emissions at the average in-use mileage.

The final step was to combine the emission estimates from the CRC and AAMA/AIAM test programs at the average in-use mileages. A weighted average of the average emissions at each sulfur test point from both programs was determined using the number of vehicles tested in each program. The CRC data was assumed to represent six vehicles (as opposed to 12), because the effect of sulfur on emissions from vehicles within the same model line were very similar. As LDTs were not tested in the CRC program, projected sulfur impacts were determined only from the AAMA/AIAM testing. The effect of increasing fuel sulfur content from 40 ppm to RFG and conventional gasoline levels was determined by taking the ratio of the combined test results at 150 and 330 ppm sulfur to those at 40 ppm. The final results of this analysis are shown in Table

8. The LDV/LDT1 corrections were used for LDVs and MOBLDT1s [16]. The LDT2/3 curve are considered applicable to MOBLDT2s, but because under NLEV these vehicles are not held to LEV standards, the LEV sulfur corrections were not applied to this truck class for this analysis.

Table 8 - Average LEV Sulfur Emission Increase From 40 ppm (percent)

Vehicle Class	NMHC		CO		NOx	
	150 ppm	330 ppm	150 ppm	330 ppm	150 ppm	330 ppm
LDV	15.7	30.3	25.0	46.9	36.0	66.5
MOBLDT1	16.5	29.5	27.0	47.6	39.6	68.9
MOBLDT2	11.3	18.3	20.0	32.3	16.7	27.0

3.3.3 Incorporation into Modified MOBILE5b

Fuel corrections in MOBILE5b pertinent to this analysis are based on emission differences between Indolene fuel and either baseline industry average (for the non-RFG case) or RFG. While these differences are strongly driven by sulfur, the MOBILE5b corrections include the effects of non-sulfur influences such as RVP and fuel composition. It was therefore desirable in the modified model to revise the sulfur impacts without altering the non-sulfur effects.

The MOBILE5b fuel correction factors were derived from EPA's Complex Model. For this analysis, the Complex Model was used to break the MOBILE5b corrections into sulfur and non-sulfur components. The revised LEV fuel corrections (for both conventional gasoline and RFG) were then developed by multiplying the MOBILE5b non-sulfur effects with the revised sulfur corrections developed in the previous section, resulting in the revised LEV correction factors (Table 9). These factors could not be input directly into the modified model, however, because the existing MOBILE5b fuel corrections were not disabled for this analysis. Incorporation of the revised fuel corrections therefore needed to take into account the corrections already imbedded in MOBILE5b. This entailed entering corrections factors which, when combined with the correction factors internal to MOBILE5, would produce the desired (“target”) factors. The adjusted correction factors entered into the modified model were developed by dividing the target correction factor by the MOBILE5b correction, so the combined result of the MOBILE5b corrections and the adjusted corrections would be the target corrections. Both the target and adjusted correction factors are shown in Table 9.

[16] Because of the higher weighting of Certification LDT2s in the MOBLDT1 class, a weighted average of the LDV/Certification LDT1 and Certification LDT2 correction is judged to be more technically correct and will be used for future analysis. Based on the results presented in Figure 9 of Section 5, this correction would reduce the 2020 NOx sulfur contribution by 15-20%, and thus will not impact the directional results of the modified model relative to MOBILE5b.

Table 9 - Final LEV Fuel Correction Factors (From Indolene)							
Model	**Correction**	**HC**		**CO**		**NOx**	
		RFG	Conv	RFG	Conv	RFG	Conv
MOBILE5b	Total	0.962	1.157	0.905	1.087	1.079	1.160
	Non-Sulfur	0.946	1.093	0.867	0.948	1.030	1.032
Modified MOBILE5b	LDV Total Target	1.094	1.424	1.084	1.393	1.401	1.718
	Adjusted	1.138	1.231	1.198	1.281	1.299	1.481
	MOBLDT1 Total	1.102	1.415	1.101	1.399	1.438	1.743
	Adjusted	1.146	1.223	1.217	1.287	1.333	1.503

The adjusted correction factors from Table 9 were applied multiplicatively to the basic emission rates with off-cycle corrections; this assumes that the percent increase due to fuel quality (primarily sulfur) observed over the FTP is applicable to aggressive driving and air conditioning emissions as well as FTP-based emissions. The correction factor was applied on a by-model year basis to years when LEVs were in the fleet. For years in which LEVs were not 100% of the fleet, the fuel correction was scaled down using the appropriate LEV phase-in percentage.

The final "adjusted" basic emission rates used by the modified MOBILE5b model, therefore, consisted of the CALIMFAC BERs with off-cycle and fuel corrections applied. These rates, shown for the Northeast and Attainment cases in Appendix A, were applied through the MOBILE5b input file using the NEWFLAG option[17]

3.4 Fleet Characteristics

Light truck sales have risen steadily over the past several years, significantly increasing market share and VMT relative to light-duty vehicles. As a result, MOBILE5 underpredicts light-truck market share, VMT and survival rates. Since trucks have higher emission rates than vehicles and older trucks are dirtier than newer trucks, an increase in truck VMT and a flattened age distribution will increase the relative contribution of older trucks to the overall inventory. Overall, the changes in VMT mix and age distribution serve to increase light-duty inventory estimates relative to MOBILE5b.

EPA will update MOBILE6 to correct these shortfalls, but the updated estimates are not yet available; therefore, related EPA work was used to develop updated fleet characteristics for this analysis. Changes in fleet characteristics were addressed in two manners: 1) altering the distribution of VMT between LDVs and LDTs, and 2) altering the age distributions for both LDVs and LDTs to reflect higher survival rates. Both revisions are discussed in the following sections.

[17]The MOBILE5b code required modification to accommodate the large number of alternate rates used, as well as alternate flex points (the point at which the deterioration rate changes) where applicable.

3.4.1 Vehicle Miles Traveled

An EPA model characterizing the growth in relative light truck VMT was used as the basis for the fleet-based modifications[18] (referred to as the "VMT model"). This model combines sales data and survival rates published by Oak Ridge National Laboratory (ORNL) to develop and estimate relative gasoline vehicle and truck VMT out to 2020; the results indicate a greater proportion of miles traveled by trucks than projected by MOBILE5b. Revised MOBILE5b VMT fractions for each scenario year were developed from the VMT model by splitting the light truck VMT projection in the given calender year into the two gasoline light truck classes used in MOBILE5b. This was done for all future calender years using an estimate from R.L. Polk for the light truck fleet breakdown in 1996 (approximately 67% MOBLDT1s and 33% MOBLDT2s)[19]. The revised light-duty fractions were then renormalized within the gasoline light-duty share afforded in MOBILE5b, resulting in the VMT mix across all vehicles classes shown in Table 10. These estimates were entered into MOBILE5b using the VMFLAG command.

Table 10 - VMT Fractions

Year	VMT Split (%)		VMT Fractions (relative to all vehicle classes)					
	LDV	LDT	LDV		MOBLDT1		MOBLDT2	
			MOBILE5b	Modified	MOBILE5b	Modified	MOBILE5b	Modified
2000	57.0	43.0	0.614	0.503	0.191	0.257	0.086	0.122
2005	50.9	49.1	0.600	0.450	0.197	0.293	0.087	0.139
2007	49.4	50.6	0.595	0.435	0.199	0.303	0.087	0.144
2010	47.0	53.0	0.589	0.415	0.201	0.317	0.088	0.150
2015	45.2	54.8	0.581	0.398	0.204	0.328	0.089	0.156
2020	44.3	55.7	0.575	0.391	0.207	0.333	0.089	0.158

3.4.2 Age Distribution

The survival rates used in the VMT model show a flatter distribution than projected by MOBILE5b, meaning that MOBILE5b underpredicts the likelihood that older vehicles (particularly trucks) will remain in operation. Revised age distributions were therefore developed for LDVs, MOBLDT1s and MOBLDT2s. ORNL survival rates (1990 for LDVs, 1979-1989 for LDTs) were used in conjunction with MOBILE5b annual mileage accumulation

[18] German, "VMT and Emission Implications of Growth in Light Truck Sales", Presented at Air and Waste Management Association Annual Conference, October 1997.

[19] Accurex Environmental Corporation, "Update of Fleet Characterization Data for Use in MOBILE6", Report for EPA, May 1997.

rates to develop revised travel fraction estimates at each vehicle age[20]. MOBILE5b's age distribution (July) was then multiplied by the ratio of the revised travel fraction to the MOBILE5b travel fraction for each year, and the resultant “raw” distribution renormalized so that it summed to one. As required by MOBILE5b, age distributions for light-duty diesel vehicles (LDDVs) and trucks (LDDTs) were set equal to their light-duty gasoline counterparts. The revised distributions (and calculation methodology) are shown in Appendix C. These distributions were implemented in the modified model using MOBILE5b's MYRFLAG option.

3.4.3 Average In-Use Mileage

The average in-use mileages used in developing both the sulfur correction factors and the FTP-based off-cycle corrections were developed by multiplying MOBILE5b’s cumulative mileage accumulation rates for LDVs, LDT1s and LDT2s by the revised travel fractions developed in the previous section, and summing the result over all years. The resultant mileage levels were 68,000 for LDVs, 81,000 for LDTs and 100,000 for LDT2s. These mileage levels represent the average in-use mileage for vehicles weighted by the contribution of overall VMT by each vehicle age.

4 MODEL EXECUTION

Execution of the MOBILE5b and modified MOBILE5b models in a way which properly evaluated the impact of the modifications and maintained consistency with the OTAG modeling work required considerable manipulation of the input files for both models. Aside from the manipulations described in Section 3 relating to adjusted BERs with off-cycle and sulfur corrections (using the NEWFLAG option) and fleet characteristics (using the VMFLAG and MYRFLAG options), required input file manipulations fell into three basic categories: treatment of Inspection/Maintenance, NLEV phase-in and out year assumptions, and general model inputs. Each are discussed below.

4.1 Inspection / Maintenance

Implementation of an enhanced I/M program was assumed for the I/M cases in this analysis. OTAG’s Round 2 Run 5 termed “high enhanced" I/M for pre-LEVs as an annual centralized program using the IM240, with cutpoints of 0.8 g/mi HC, 15.0 g/mi CO and 2.0 g/mi NOx; for LEVs, “maximum” I/M (under which vehicles are assumed to meet the applicable standards over their full useful life) was assumed. Detailed program elements are listed in Table 11, and were entered into the model using the IMFLAG option. However, because it was not appropriate to use these inputs in conjunction with the CALIMFAC “with I/M” emission rates, they were only used in the modified model for model years 1983 through 1987; starting in 1988, I/M effects in the modified model were accounted for solely through the CALIMFAC rates.

[20]Travel Fraction, Year X = Annual Mileage in Year X / ∑ (Mileage * Survival Rate)

An anti-tampering program was included as part of the enhanced I/M program as modeled in OTAG's Round 2 Run 5 (Table 11). For MOBILE5b this program was modeled directly, which resulted in essentially zero tampering impact. For the modified model, however, the CALIMFAC "with I/M" rates already incorporated the benefits of an anti-tampering program, so application of the MOBILE5b tampering adjustments to the CALIMFAC emission rates was not appropriate. Therefore, to best represent the effects of an anti-tampering program in the modified model, tampering effects were set to zero using TAMFLAG[21]. In terms of comparison between the modified model and MOBILE5b, this primarily impacted heavy-duty gasoline vehicles (HDGVs), which the OTAG ATP program did not cover (leaving the tampering emissions intact for these vehicles); as a result, the MOBILE5b HDGV results are slightly higher than the modified model results.

An evaporative pressure/purge test was also modeled as part of the enhanced I/M program under OTAG (Table 11). Because none of the modifications made to MOBILE5b affected evaporative emissions, the pressure/purge parameters were not altered for the modified model.

Table 11 - I/M, Pressure/Purge, and Anti-Tampering Program Assumptions

Characteristic	I/M 1	I/M 2	Pressure	Purge	ATP
Stringency	20%	20%			
First Model Year	1968	1986	1983	1986	1984
Last Model Year	1985	2020			
Pre-1981 Waiver Rate	3%	3%			
Post-1981 Waiver Rate	3%	3%			
Compliance Rate	96%	96%	96%	96%	96%
Program Type	Centralized	Centralized	Centralized	Centralized	Centralized
Inspection Frequency	Annual	Annual	Annual	Annual	Annual
Vehicle Types	LDGV/T1/T2	LDGV/T1/T2	LDGV/T1/T2	LDGV/T1/T2	LDGV/T1/T2
Test Type	2500/Idle	IM240			
Cutpoints (HC/CO/NOx)	none	0.8/20.0/2.0			
Inspections Performed	ATP Only: Catalyst, Fuel Inlet Restrictor				

4.2 NLEV

For MOBILE5b, NLEV was modeled using the phase-in schedule used for OTAG for both the OTR and non-OTR regions (shown in Table 2). In terms of the model, this requires setting the PROMPT flag to "5" and specifying the phase-in schedule through an external file. For the modified model, the impact of NLEV was handled through the weighting of the revised emission

[21]This option was developed for internal EPA use, and is not allowed in SIP submissions.

rates (as discussed in Section 3.1), so this option was not enacted. For the non-OTR case, 1996 emission rates were extended through 2000. For all cases, it was assumed that emission rates would stabilize at SFTP-controlled LEV levels in 2004 (the first year of 100% LEV SFTP compliance) and remain constant through 2020. Tier 1 off-cycle correction factors were applied to MOBLDT2s under the EPA phase-in schedule; full SFTP phase-in for these vehicles also occurs in 2004, so emission rates were held constant from 2004 through 2020 for these vehicles as well.

4.3 <u>Other Model Inputs</u>

Additional inputs used to run both models are discussed below:

Speed: An average speed of 24.6 mph was used for all model runs. This speed is the average speed of the LA92 cycle, and was thus considered a reasonable estimate of average in-use speed. This represented an approximation of the OTAG modeling, for which county-by-county speed information was applied.

Temperature: A daily temperature range of 72° F to 96° F has been used in past EPA regulatory analyses to approximate typical high ozone day temperatures. This again represented an approximation of the OTAG work, which applied temperature data on a county-by-county basis. However, because OTAG modeled time periods during which significant ozone episodes occurred, this temperature range is a reasonable approximation of the OTAG temperatures.

Fuel RVP: To maintain consistency with OTAG, RVP was specified at 11.5 prior to 1992, and 8.7 for 1992 and later. For RFG cases, these levels were overridden by the RFG RVPs (Phase 1 and 2) used by MOBILE5b on the appropriate implementation schedule.

Month: All runs were made in July to enable full RFG benefit.

HC: Additive methane offsets imbedded in MOBILE5b were not appropriate for the modified MOBILE5b THC emissions rates. While MOBILE5b was run to produce NMHC results (using the HCFLAG), the modified model was run to produce THC results. NMHC results from the modified model were then calculated by applying the NMHC/THC ratio from MOBILE5b to the modified MOBILE5b THC results for each vehicle class and scenario year.

5 RESULTS

For each of the four cases discussed in Section 2, MOBILE5b and the modified MOBILE5b were run for a range of calendar years (2000, 2005, 2007, 2010, 2015 and 2020) to provide a direct comparison between the models in the OTAG scenario year (2007), and observe how differences between the models changed over time. Results for all four cases broken down by vehicle class are contained in Appendix D.

Figures 6 through 8 show NOx, NMHC, and CO emission factors from 2000 through 2020 for both models in the Northeast and Attainment emission control scenarios. For the Northeast case, the modified MOBILE5b model projects higher emissions than MOBILE5b over most years; the two models converge for HC and CO towards 2020, while NOx in the modified model remains higher. Comparison of the two models yield similar results for the other two control scenarios which include high enhanced I/M. For the Attainment case, the modified MOBILE5b model projects higher emissions relative to MOBILE5b in the earlier years, but drops below MOBILE5b by 2010. The primary reason for the difference between the two cases is the absence of high enhanced I/M; without this degree of I/M, MOBILE5b projects that LEVs emit substantially above their standards, and use of the CALIMFAC emission rates significantly reduces base emissions.

Figure 6 - NOx Results for Northeast and Attainment Cases

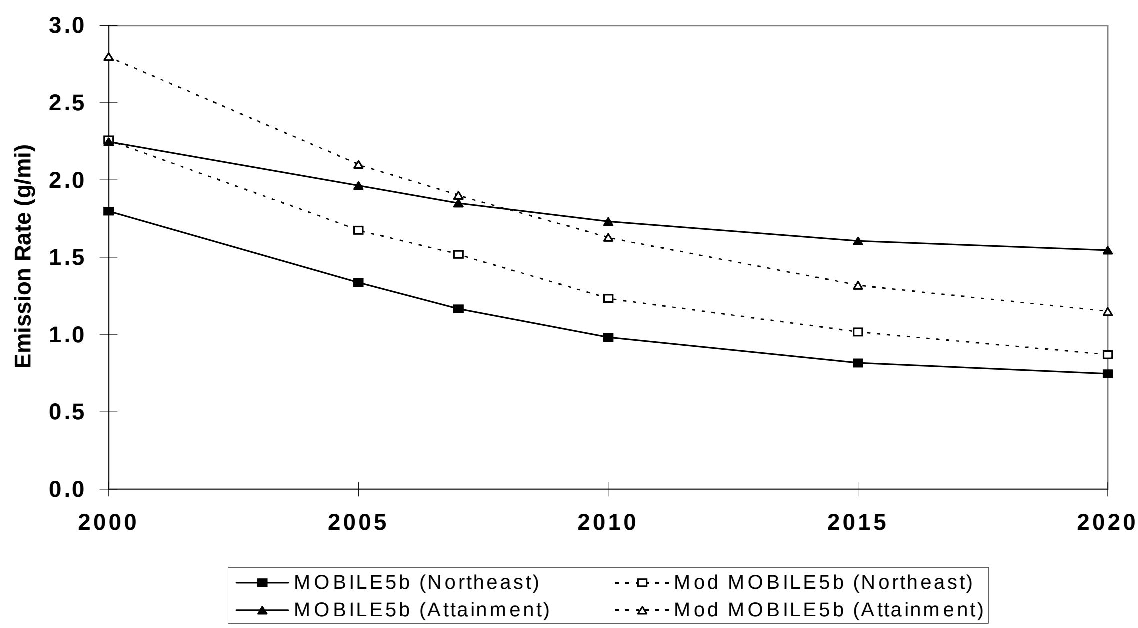


Figure 7 - NMHC Results for Northeast and Attainment Cases

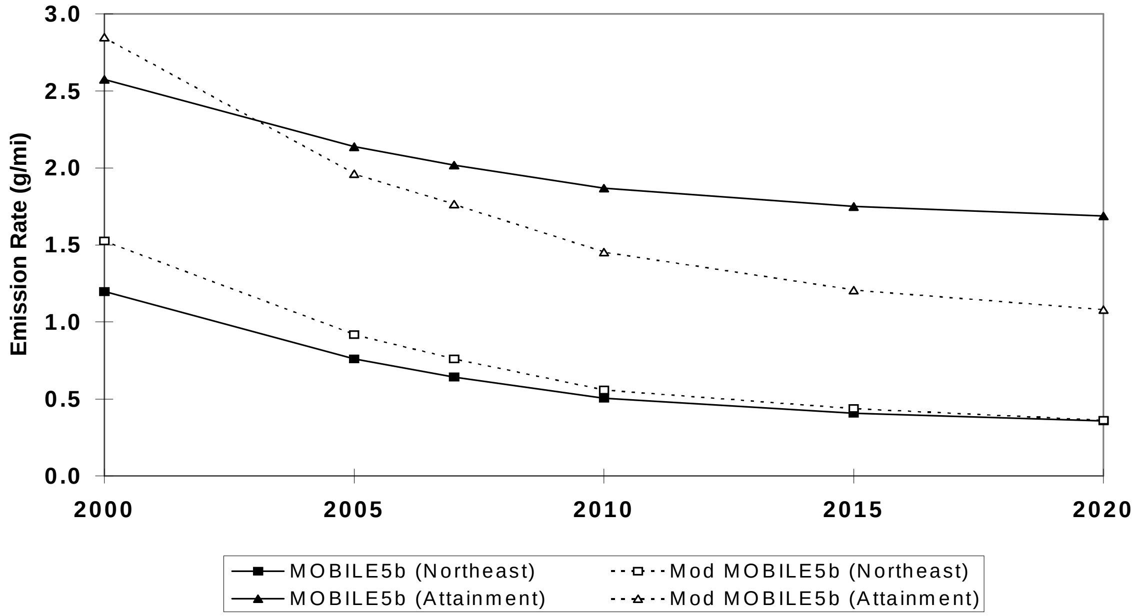
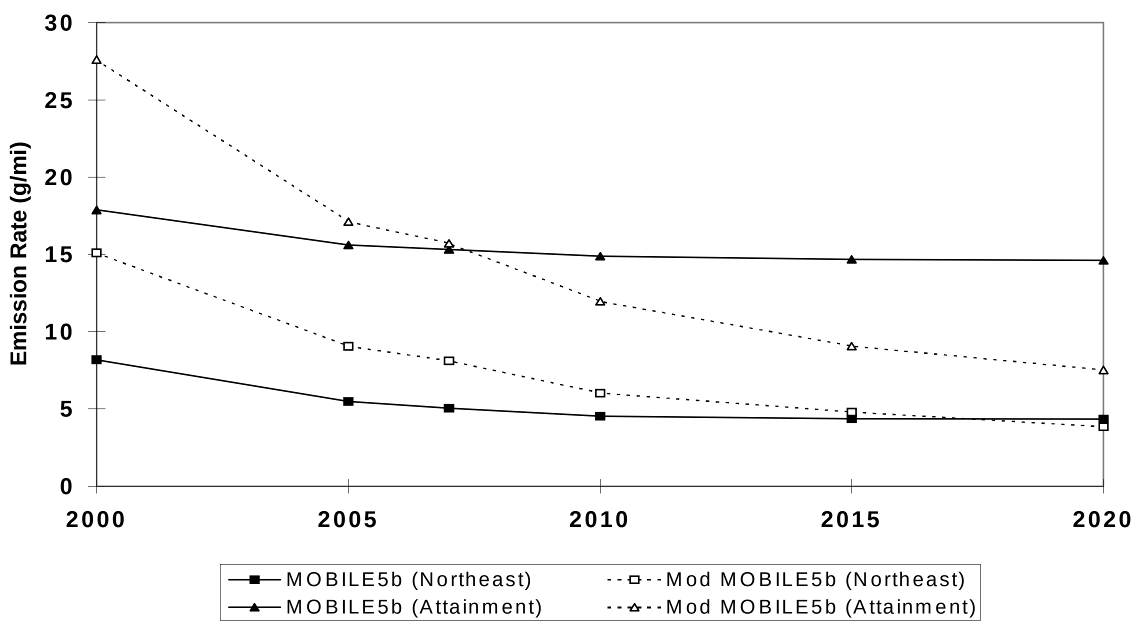
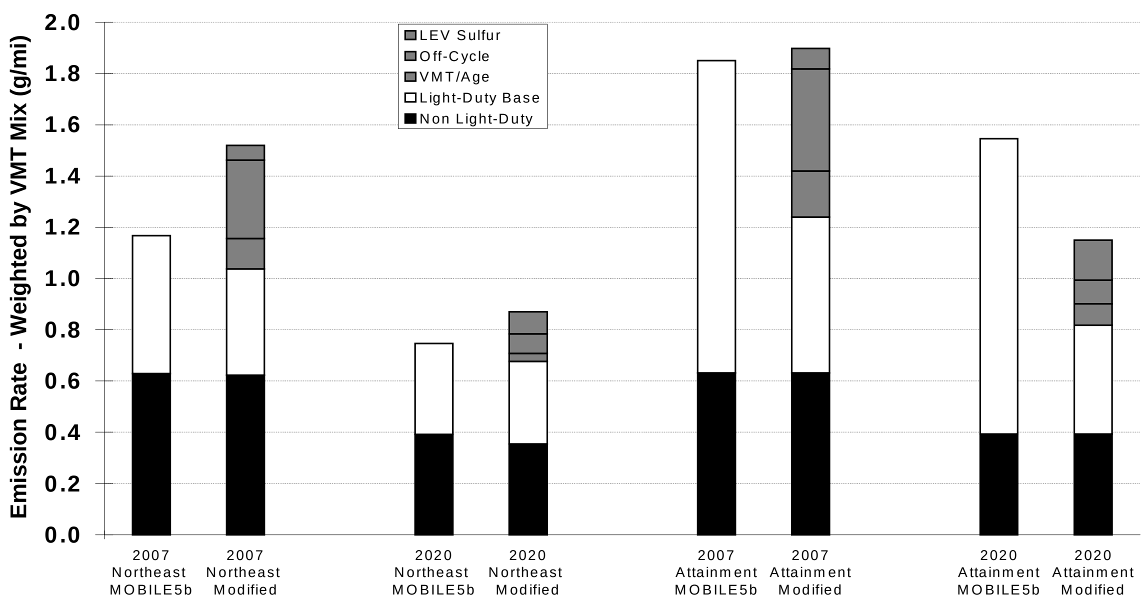


Figure 8 - CO Results for Northeast and Attainment Cases



Figures 9 through 11 show results from the Northeast and Attainment cases in 2007 and 2020 broken down into the individual contribution of each of the four primary modifications (basic emission rates, off-cycle, sulfur and fleet characteristics). These figures show that for both cases in 2007, the off-cycle and fleet modifications are the primary drivers of the modified MOBILE5b increases for all pollutants. In 2020, increased fleet turnover of SFTP-compliant vehicles decrease the off-cycle impact, while the prevalence of LEVs increases the relative sulfur impact (primarily for NOx). These figures again illustrate the importance of I/M assumptions in comparing the affect of the modifications. There is little difference in the contribution of base emission rates between the modified and unmodified MOBILE5b models when high enhanced I/M is present. However, without high enhanced I/M, the lower deterioration rates dominate the other factors and the modified model projects lower overall emissions. It is also important to note that the high light-duty NMHC contribution relative to non light-duty is driven largely by evaporative emissions.

Figure 9 - NOx Breakdown



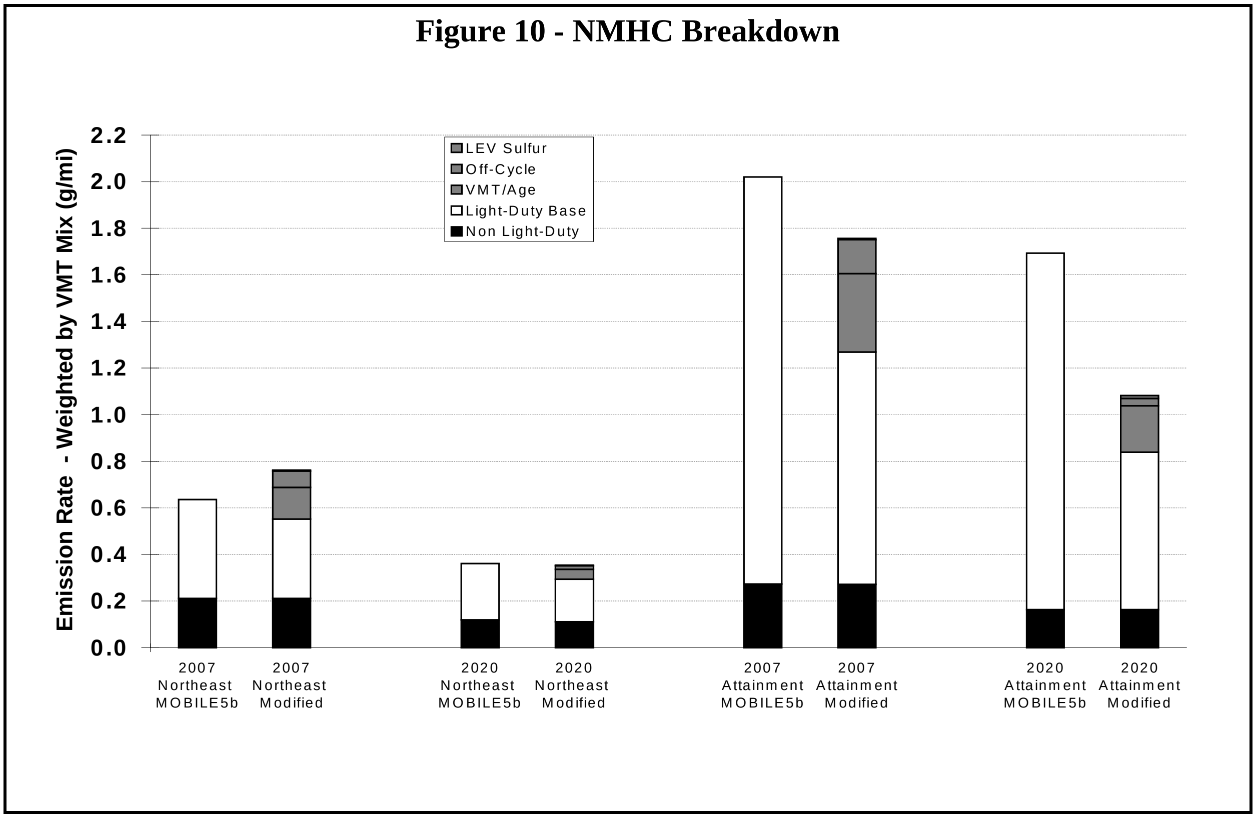


Figure 10 - NMHC Breakdown
Emission Rate - Weighted by VMT Mix (g/mi)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
LEV Sulfur
Off-Cycle
VMT/Age
Light-Duty Base
Non Light-Duty
2007 Northeast MOBILE5b
2007 Northeast Modified
2020 Northeast MOBILE5b
2020 Northeast Modified
2007 Attainment MOBILE5b
2007 Attainment Modified
2020 Attainment MOBILE5b
2020 Attainment Modified

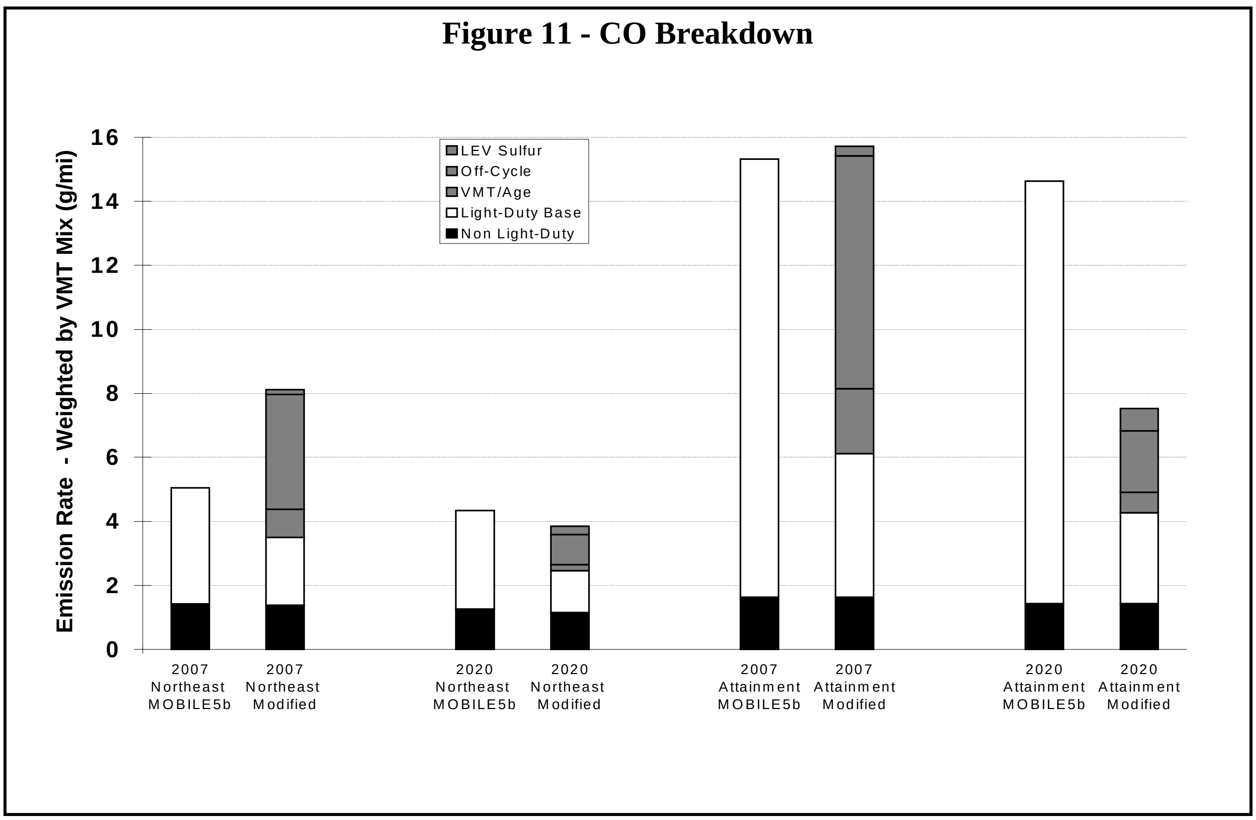


Figure 11 - CO Breakdown
Emission Rate - Weighted by VMT Mix (g/mi)
16
14
12
10
8
6
4
2
0
LEV Sulfur
Off-Cycle
VMT/Age
Light-Duty Base
Non Light-Duty
2007 Northeast MOBILE5b
2007 Northeast Modified
2020 Northeast MOBILE5b
2020 Northeast Modified
2007 Attainment MOBILE5b
2007 Attainment Modified
2020 Attainment MOBILE5b
2020 Attainment Modified

Overall, these results indicate that the effects of off-cycle emissions, increased sulfur sensitivity, increased LDT VMT and longer vehicle survival more than offset the effect of lower in-use deterioration rates in the MOBILE model for nonattainment areas with high enhanced I/M programs. To what extent these results are duplicated in MOBILE6 will of course depend on the how different the final MOBILE6 basic emission rates are from the CALIMFAC rates. However, because of the assumptions made by MOBILE5b regarding high enhanced I/M, it is likely that this trend will carry over to MOBILE6.

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Appendix A - Modified MOBILE5b Emission Rates

Table A-1: LDV (Northeast Case)

Model Year	HC						CO						NOx					
	Base			Adjusted			Base			Adjusted			Base			Adjusted		
	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2
1983	0.241	0.089	0.274	0.299	0.110	0.340	3.255	1.549	3.345	7.291	3.470	7.493	0.578	0.067	0.199	0.983	0.114	0.338
1984	0.247	0.073	0.282	0.306	0.091	0.350	3.184	1.193	3.604	7.132	2.672	8.073	0.465	0.079	0.224	0.791	0.134	0.381
1985	0.249	0.077	0.284	0.309	0.095	0.352	2.920	1.331	3.547	6.541	2.981	7.945	0.469	0.078	0.210	0.797	0.133	0.357
1986	0.253	0.071	0.282	0.314	0.088	0.350	2.740	1.240	3.554	6.138	2.778	7.961	0.425	0.082	0.214	0.723	0.139	0.364
1987	0.253	0.070	0.271	0.314	0.087	0.336	2.704	1.242	3.403	6.057	2.782	7.623	0.442	0.078	0.213	0.751	0.133	0.362
1988	0.292	0.042		0.362	0.052		3.566	0.575		7.987	1.287		0.510	0.042		0.867	0.072	
1989	0.294	0.039		0.365	0.048		3.461	0.586		7.752	1.314		0.404	0.032		0.686	0.055	
1990	0.298	0.036		0.370	0.045		3.511	0.589		7.865	1.320		0.323	0.024		0.549	0.041	
1991	0.298	0.036		0.370	0.044		3.511	0.579		7.865	1.297		0.323	0.023		0.549	0.040	
1992	0.298	0.035		0.370	0.043		3.511	0.571		7.865	1.279		0.323	0.022		0.549	0.038	
1993	0.298	0.035		0.370	0.043		3.511	0.571		7.865	1.279		0.323	0.022		0.549	0.038	
1994	0.242	0.027		0.352	0.039		2.571	0.440		6.438	1.102		0.317	0.021		0.546	0.036	
1995	0.185	0.018		0.310	0.031		1.631	0.309		4.514	0.856		0.312	0.020		0.543	0.034	
1996	0.157	0.014		0.279	0.025		1.161	0.244		3.367	0.707		0.309	0.019		0.541	0.033	
1997	0.123	0.012		0.219	0.021		1.161	0.244		3.367	0.707		0.309	0.019		0.541	0.033	
1998	0.123	0.012		0.219	0.021		1.161	0.244		3.367	0.707		0.309	0.019		0.541	0.033	
1999	0.088	0.009		0.163	0.017		0.813	0.255		2.497	0.782		0.270	0.016		0.515	0.030	
2000	0.053	0.006		0.102	0.012		0.464	0.265		1.507	0.861		0.231	0.012		0.477	0.026	
2001	0.039	0.005		0.071	0.009		0.000	0.280		0.000	0.846		0.179	0.008		0.371	0.017	
2002	0.039	0.005		0.063	0.008		0.000	0.280		0.000	0.720		0.179	0.008		0.335	0.015	
2003	0.039	0.005		0.051	0.007		0.000	0.280		0.000	0.545		0.179	0.008		0.284	0.013	
2004-20	0.039	0.005		0.046	0.006		0.000	0.280		0.000	0.469		0.179	0.008		0.263	0.012	

Appendix A - Modified MOBILE5b Emission Rates

Table A-2: MOBLDT1 (Northeast Case)

Model Year	HC						CO						NOx					
	Base			Adjusted			Base			Adjusted			Base			Adjusted		
	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2
1983	0.820	0.150		0.992	0.182		12.580	1.460		26.921	3.124		1.6400	0.0300		2.755	0.050	
1984	0.700	0.150		0.847	0.182		9.430	1.460		20.180	3.124		1.1200	0.0700		1.882	0.118	
1985	0.408	0.077		0.494	0.093		5.074	1.331		10.858	2.848		1.1160	0.0780		1.875	0.131	
1986	0.392	0.071		0.474	0.086		4.642	1.240		9.934	2.654		0.9850	0.0820		1.655	0.138	
1987	0.377	0.070		0.456	0.085		4.358	1.242		9.326	2.658		0.8380	0.0780		1.408	0.131	
1988	0.294	0.048		0.355	0.058		3.712	0.778		7.944	1.664		0.5954	0.0583		1.000	0.098	
1989	0.294	0.047		0.355	0.057		3.716	0.764		7.953	1.634		0.5961	0.0555		1.001	0.093	
1990	0.294	0.044		0.356	0.053		3.629	0.716		7.766	1.532		0.5854	0.0506		0.983	0.085	
1991	0.296	0.039		0.358	0.048		3.498	0.658		7.485	1.408		0.5695	0.0450		0.957	0.076	
1992	0.296	0.037		0.358	0.045		3.455	0.637		7.393	1.364		0.5641	0.0422		0.948	0.071	
1993	0.296	0.037		0.358	0.045		3.455	0.637		7.394	1.363		0.5641	0.0422		0.948	0.071	
1994	0.235	0.029		0.333	0.041		2.498	0.487		5.974	1.164		0.4588	0.0335		0.782	0.057	
1995	0.174	0.020		0.282	0.033		1.540	0.337		4.072	0.890		0.3535	0.0248		0.611	0.043	
1996	0.144	0.016		0.248	0.028		1.061	0.261		2.940	0.724		0.3009	0.0205		0.524	0.036	
1997	0.110	0.013		0.189	0.022		1.061	0.261		2.940	0.724		0.3009	0.0205		0.524	0.036	
1998	0.110	0.013		0.189	0.022		1.061	0.261		2.940	0.724		0.3009	0.0205		0.524	0.036	
1999	0.074	0.009		0.133	0.016		0.743	0.237		2.192	0.698		0.3000	0.0189		0.574	0.036	
2000	0.038	0.005		0.072	0.009		0.425	0.212		1.329	0.663		0.2992	0.0172		0.625	0.036	
2001	0.025	0.004		0.044	0.006		0.000	0.179		0.000	0.531		0.2980	0.0150		0.629	0.032	
2002	0.025	0.004		0.039	0.006		0.000	0.179		0.000	0.460		0.2980	0.0150		0.566	0.028	
2003	0.025	0.004		0.032	0.005		0.000	0.179		0.000	0.360		0.2980	0.0150		0.478	0.024	
2004-20	0.025	0.004		0.029	0.004		0.000	0.179		0.000	0.318		0.2980	0.0150		0.441	0.022	

Appendix A - Modified MOBILE5b Emission Rates

Table A-3: MOBLDT2 (Northeast Case)

Model Year	HC						CO						NOx					
	Base			Adjusted			Base			Adjusted			Base			Adjusted		
	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2	ZML	DR1	DR2
1983	0.820	0.150		0.992	0.182		12.580	1.460		26.418	3.066		1.640	0.030		2.755	0.050	
1984	0.700	0.150		0.847	0.182		9.430	1.460		19.803	3.066		1.120	0.070		1.882	0.118	
1985	0.408	0.077		0.494	0.093		5.074	1.331		10.655	2.795		1.116	0.078		1.875	0.131	
1986	0.392	0.071		0.474	0.086		4.642	1.240		9.748	2.604		0.985	0.082		1.655	0.138	
1987	0.377	0.070		0.456	0.085		4.358	1.242		9.152	2.608		0.838	0.078		1.408	0.131	
1988	0.305	0.047		0.369	0.057		4.611	0.890		9.683	1.870		0.791	0.059		1.329	0.099	
1989	0.307	0.046		0.372	0.055		4.648	0.931		9.761	1.956		0.800	0.058		1.345	0.097	
1990	0.303	0.041		0.367	0.049		4.273	0.849		8.974	1.784		0.788	0.056		1.324	0.094	
1991	0.304	0.039		0.368	0.048		4.358	0.905		9.153	1.901		0.789	0.056		1.326	0.094	
1992	0.303	0.036		0.366	0.044		4.132	0.871		8.678	1.830		0.787	0.054		1.323	0.091	
1993	0.301	0.033		0.364	0.040		3.789	1.040		7.957	2.185		0.785	0.052		1.318	0.087	
1994	0.300	0.301		0.363	0.037		3.675	1.068		7.716	2.243		0.784	0.051		1.317	0.085	
1995	0.300	0.031		0.363	0.037		3.675	1.109		7.716	2.330		0.784	0.050		1.317	0.084	
1996	0.220	0.023		0.324	0.034		2.324	0.686		5.612	1.658		0.541	0.035		0.925	0.060	
1997	0.140	0.016		0.243	0.028		0.973	0.263		2.657	0.719		0.298	0.020		0.518	0.035	
1998	0.140	0.016		0.243	0.028		0.973	0.263		2.657	0.719		0.298	0.020		0.518	0.035	
1999	0.140	0.016		0.243	0.028		0.973	0.263		2.657	0.719		0.298	0.020		0.518	0.035	
2000	0.140	0.016		0.243	0.028		0.973	0.263		2.657	0.719		0.298	0.020		0.518	0.035	
2001	0.140	0.016		0.243	0.028		0.973	0.263		2.657	0.719		0.298	0.020		0.518	0.035	
2002	0.140	0.016		0.206	0.024		0.973	0.263		2.162	0.585		0.298	0.020		0.454	0.031	
2003	0.140	0.016		0.170	0.019		0.973	0.263		1.668	0.451		0.298	0.020		0.389	0.026	
2004-20	0.140	0.016		0.151	0.017		0.973	0.263		1.421	0.385		0.298	0.020		0.357	0.024	

Appendix A - Modified MOBILE5b Emission Rates

Table A-4: LDV (Attainment Case)

Model Year	HC							CO							NOx						
	Flex	Base			Adjusted			Flex	Base			Adjusted			Flex	Base			Adjusted		
		ZM	DR1	DR2	ZML	DR1	DR2		ZML	DR1	DR2	ZML	DR1	DR2		ZML	DR1	DR2	ZML	DR1	DR2
1983	5.00	0.241	0.089	0.274	0.299	0.110	0.340	5.00	3.255	1.549	3.345	7.291	3.470	7.493	5.00	0.578	0.067	0.199	0.983	0.114	0.338
1984	5.00	0.247	0.073	0.282	0.306	0.091	0.350	5.00	3.184	1.193	3.604	7.132	2.672	8.073	5.00	0.465	0.079	0.224	0.791	0.134	0.381
1985	5.00	0.249	0.077	0.284	0.309	0.095	0.352	5.00	2.920	1.331	3.547	6.541	2.981	7.945	5.00	0.469	0.078	0.210	0.797	0.133	0.357
1986	5.00	0.253	0.071	0.282	0.314	0.088	0.350	5.00	2.740	1.240	3.554	6.138	2.778	7.961	5.00	0.425	0.082	0.214	0.723	0.139	0.364
1987	5.00	0.253	0.070	0.271	0.314	0.087	0.336	5.00	2.704	1.242	3.403	6.057	2.782	7.623	5.00	0.442	0.078	0.213	0.751	0.133	0.362
1988	9.68	0.292	0.078	0.022	0.362	0.097	0.027	12.12	3.566	1.237	0.670	7.987	2.772	1.501	10.55	0.510	0.081	0.023	0.867	0.138	0.038
1989	9.68	0.294	0.076	0.023	0.365	0.094	0.029	12.12	3.461	1.272	0.629	7.752	2.849	1.408	10.55	0.404	0.064	0.015	0.686	0.109	0.026
1990	10.55	0.298	0.074	0.014	0.370	0.092	0.017	12.12	3.511	1.268	0.574	7.865	2.840	1.286	10.55	0.323	0.052	0.012	0.549	0.088	0.020
1991	10.55	0.298	0.074	0.014	0.370	0.092	0.017	12.12	3.511	1.268	0.574	7.865	2.840	1.286	10.55	0.323	0.052	0.012	0.549	0.088	0.020
1992	10.55	0.298	0.074	0.014	0.370	0.092	0.017	12.12	3.511	1.268	0.574	7.865	2.840	1.286	10.55	0.323	0.052	0.012	0.549	0.088	0.020
1993	10.55	0.298	0.074	0.014	0.370	0.092	0.017	12.12	3.511	1.268	0.574	7.865	2.840	1.286	10.55	0.323	0.052	0.012	0.549	0.088	0.020
1994	12.49	0.242	0.054	0.021	0.352	0.079	0.031	14.57	2.571	0.917	0.536	6.438	2.296	1.342	11.74	0.317	0.042	0.015	0.546	0.072	0.026
1995	14.42	0.185	0.034	0.028	0.310	0.058	0.047	17.02	1.631	0.566	0.498	4.514	1.567	1.380	12.92	0.312	0.032	0.019	0.543	0.056	0.033
1996	15.39	0.157	0.025	0.032	0.279	0.044	0.057	18.25	1.161	0.391	0.480	3.367	1.133	1.391	13.52	0.309	0.028	0.021	0.541	0.048	0.037
1997	15.39	0.157	0.025	0.032	0.279	0.044	0.057	18.25	1.161	0.391	0.480	3.367	1.133	1.391	13.52	0.309	0.028	0.021	0.541	0.048	0.037
1998	15.39	0.157	0.025	0.032	0.279	0.044	0.057	18.25	1.161	0.391	0.480	3.367	1.133	1.391	13.52	0.309	0.028	0.021	0.541	0.048	0.037
1999	15.39	0.157	0.025	0.032	0.279	0.044	0.057	18.25	1.161	0.391	0.480	3.367	1.133	1.391	13.52	0.309	0.028	0.021	0.541	0.048	0.037
2000	15.39	0.157	0.025	0.032	0.279	0.044	0.057	18.25	1.161	0.391	0.480	3.367	1.133	1.391	13.52	0.309	0.028	0.021	0.541	0.048	0.037
2001	15.39	0.039	0.009	0.012	0.077	0.018	0.023	18.25	0.000	0.482	0.986	0.000	1.560	3.191	13.52	0.179	0.012	0.010	0.423	0.029	0.023
2002	15.39	0.039	0.009	0.012	0.068	0.016	0.021	18.25	0.000	0.482	0.986	0.000	1.329	2.717	13.52	0.179	0.012	0.010	0.382	0.026	0.021
2003	15.39	0.039	0.009	0.012	0.055	0.013	0.017	18.25	0.000	0.482	0.986	0.000	1.004	2.053	13.52	0.179	0.012	0.010	0.324	0.022	0.018
2004-20	15.39	0.039	0.009	0.012	0.049	0.011	0.015	18.25	0.000	0.482	0.986	0.000	0.865	1.769	13.52	0.179	0.012	0.010	0.300	0.020	0.017

Appendix A - Modified MOBILE5b Emission Rates

Table A-4: MOBLDT1 (Attainment Case)

Model Year	HC							CO							NOx						
	Flex	Base			Adjusted			Flex	Base			Adjusted			Flex	Base			Adjusted		
		ZM	DR1	DR2	ZML	DR1	DR2		ZML	DR1	DR2	ZML	DR1	DR2		ZML	DR1	DR2	ZML	DR1	DR2
1983		0.820	0.150		0.992	0.182			12.580	1.460		26.92	3.124			1.640	0.030		2.755	0.050	
1984		0.700	0.150		0.847	0.182			9.430	1.460		20.18	3.124			1.120	0.070		1.882	0.118	
1985		0.408	0.077		0.494	0.093			5.074	1.331		10.85	2.848			1.116	0.078		1.875	0.131	
1986		0.392	0.071		0.474	0.086			4.642	1.240		9.934	2.654			0.985	0.082		1.655	0.138	
1987		0.377	0.070		0.456	0.085			4.358	1.242		9.326	2.658			0.838	0.078		1.408	0.131	
1988	9.21	0.294	0.085	0.031	0.355	0.103	0.038	11.04	3.712	1.425	0.708	7.944	3.050	1.515	11.04	0.595	0.103	0.033	1.000	0.174	0.055
1989	9.21	0.294	0.086	0.031	0.355	0.103	0.038	11.04	3.716	1.427	0.706	7.953	3.053	1.510	11.04	0.596	0.104	0.033	1.001	0.174	0.056
1990	9.21	0.294	0.083	0.032	0.356	0.101	0.038	11.04	3.629	1.391	0.761	7.766	2.978	1.629	11.04	0.585	0.099	0.028	0.983	0.166	0.048
1991	9.21	0.296	0.080	0.032	0.358	0.096	0.039	11.04	3.498	1.346	0.845	7.485	2.881	1.808	11.04	0.570	0.092	0.021	0.957	0.154	0.036
1992	9.21	0.296	0.079	0.032	0.358	0.095	0.039	11.04	3.455	1.330	0.872	7.393	2.847	1.867	11.04	0.564	0.089	0.019	0.948	0.150	0.032
1993	9.21	0.296	0.079	0.032	0.358	0.095	0.039	11.04	3.455	1.330	0.872	7.393	2.847	1.867	11.04	0.564	0.089	0.019	0.948	0.150	0.032
1994	11.83	0.235	0.058	0.035	0.333	0.082	0.049	13.83	2.497	0.958	1.033	5.973	2.293	2.470	11.96	0.459	0.065	0.021	0.782	0.111	0.036
1995	14.45	0.174	0.037	0.038	0.282	0.060	0.061	16.62	1.540	0.587	1.193	4.072	1.551	3.154	12.88	0.354	0.041	0.024	0.611	0.071	0.041
1996	15.76	0.144	0.026	0.039	0.248	0.045	0.067	18.02	1.061	0.401	1.273	2.940	1.110	3.527	13.34	0.301	0.029	0.025	0.524	0.050	0.043
1997	15.76	0.144	0.026	0.039	0.248	0.045	0.067	18.02	1.061	0.401	1.273	2.940	1.110	3.527	13.34	0.301	0.029	0.025	0.524	0.050	0.043
1998	15.76	0.144	0.026	0.039	0.248	0.045	0.067	18.02	1.061	0.401	1.273	2.940	1.110	3.527	13.34	0.301	0.029	0.025	0.524	0.050	0.043
1999	15.76	0.144	0.026	0.039	0.248	0.045	0.067	18.02	1.061	0.401	1.273	2.940	1.110	3.527	13.34	0.301	0.029	0.025	0.524	0.050	0.043
2000	15.76	0.144	0.026	0.039	0.248	0.045	0.067	18.02	1.061	0.401	1.273	2.940	1.110	3.527	13.34	0.301	0.029	0.025	0.524	0.050	0.043
2001	15.76	0.025	0.006	0.009	0.047	0.011	0.017	18.01	0.000	0.296	1.613	0.000	0.931	5.071	13.34	0.298	0.022	0.020	0.709	0.052	0.047
2002	15.76	0.025	0.006	0.009	0.042	0.010	0.015	18.01	0.000	0.296	1.613	0.000	0.807	4.391	13.34	0.298	0.022	0.020	0.638	0.047	0.042
2003	15.76	0.025	0.006	0.009	0.034	0.008	0.012	18.01	0.000	0.296	1.613	0.000	0.632	3.439	13.34	0.298	0.022	0.020	0.539	0.039	0.036
2004-20	15.76	0.025	0.006	0.009	0.031	0.007	0.011	18.01	0.000	0.296	1.613	0.000	0.557	3.031	13.34	0.298	0.022	0.020	0.497	0.036	0.033

Appendix A - Modified MOBILE5b Emission Rates

Table A-6: MOBLDT2 (Attainment Case)

Model Year	HC							CO							NOx						
	Flex	Base			Adjusted			Flex	Base			Adjusted			Flex	Base			Adjusted		
		ZM	DR1	DR2	ZML	DR1	DR2		ZML	DR1	DR2	ZML	DR1	DR2		ZML	DR1	DR2	ZML	DR1	DR2
1983		0.820	0.150		0.992	0.182			12.580	1.460		26.41	3.066			1.640	0.030		2.755	0.050	
1984		0.700	0.150		0.847	0.182			9.430	1.460		19.80	3.066			1.120	0.070		1.882	0.118	
1985		0.408	0.077		0.494	0.093			5.074	1.331		10.65	2.795			1.116	0.078		1.875	0.131	
1986		0.392	0.071		0.474	0.086			4.642	1.240		9.748	2.604			0.985	0.082		1.655	0.138	
1987		0.377	0.070		0.456	0.085			4.358	1.242		9.152	2.608			0.838	0.078		1.408	0.131	
1988	10.01	0.305	0.113	0.014	0.369	0.137	0.017	10.98	4.611	1.871	0.377	9.683	3.928	0.791	10.98	0.791	0.108	0.040	1.329	0.181	0.068
1989	10.01	0.307	0.115	0.014	0.372	0.140	0.017	10.98	4.648	1.889	0.371	9.761	3.967	0.780	10.98	0.800	0.109	0.042	1.345	0.182	0.070
1990	10.01	0.303	0.106	0.016	0.367	0.128	0.019	10.98	4.273	1.745	0.528	8.974	3.665	1.109	10.98	0.788	0.107	0.033	1.324	0.180	0.056
1991	10.01	0.304	0.108	0.015	0.368	0.130	0.018	10.98	4.358	1.777	0.490	9.153	3.732	1.029	10.98	0.789	0.107	0.035	1.326	0.180	0.059
1992	10.01	0.303	0.102	0.016	0.366	0.124	0.020	10.98	4.132	1.693	0.591	8.678	3.556	1.242	10.98	0.787	0.107	0.030	1.323	0.180	0.051
1993	10.01	0.301	0.094	0.018	0.364	0.114	0.022	10.98	3.789	1.566	0.746	7.957	3.288	1.566	10.98	0.785	0.107	0.023	1.318	0.179	0.038
1994	10.01	0.300	0.092	0.019	0.363	0.111	0.023	10.98	3.675	1.523	0.797	7.716	3.198	1.674	10.98	0.784	0.107	0.020	1.317	0.179	0.034
1995	10.01	0.300	0.092	0.019	0.363	0.111	0.023	10.98	3.675	1.523	0.797	7.716	3.198	1.674	10.98	0.784	0.107	0.020	1.317	0.179	0.034
1996	12.70	0.220	0.059	0.027	0.324	0.087	0.039	14.74	2.324	0.969	0.877	5.612	2.341	2.119	12.21	0.541	0.068	0.021	0.925	0.116	0.036
1997	15.39	0.140	0.027	0.035	0.243	0.047	0.060	18.50	0.973	0.416	0.958	2.657	1.134	2.614	13.45	0.298	0.030	0.022	0.518	0.051	0.038
1998	15.39	0.140	0.027	0.035	0.243	0.047	0.060	18.50	0.973	0.416	0.958	2.657	1.134	2.614	13.45	0.298	0.030	0.022	0.518	0.051	0.038
1999	15.39	0.140	0.027	0.035	0.243	0.047	0.060	18.50	0.973	0.416	0.958	2.657	1.134	2.614	13.45	0.298	0.030	0.022	0.518	0.051	0.038
2000	15.39	0.140	0.027	0.035	0.243	0.047	0.060	18.50	0.973	0.416	0.958	2.657	1.134	2.614	13.45	0.298	0.030	0.022	0.518	0.051	0.038
2001	15.39	0.140	0.027	0.035	0.243	0.047	0.060	18.50	0.973	0.416	0.958	2.657	1.134	2.614	13.45	0.298	0.030	0.022	0.518	0.051	0.038
2002	15.39	0.140	0.027	0.035	0.206	0.040	0.051	18.50	0.973	0.416	0.958	2.162	0.923	2.128	13.45	0.298	0.030	0.022	0.454	0.045	0.033
2003	15.39	0.140	0.027	0.035	0.170	0.033	0.042	18.50	0.973	0.416	0.958	1.668	0.712	1.641	13.45	0.298	0.030	0.022	0.389	0.039	0.028
2004-20	15.39	0.140	0.027	0.035	0.151	0.029	0.037	18.50	0.973	0.416	0.958	1.421	0.607	1.398	13.45	0.298	0.030	0.022	0.357	0.035	0.026

Appendix B: Methodology for Developing LEV SFTP Benefits

The determination of LEV SFTP benefits was based on an assessment of the stringency of ARB's SFTP standards relative the EPA's standards. For US06, the basis for determining the relative stringency of the ARB and EPA standards was a comparison between the US06 standards and an approximation of the applicable "running" FTP standards. Running FTP standards were estimated by multiplying the 50K FTP standards (NMHC+NOx and CO) by a running/FTP factor of 0.65, calculated based on start/running fractions from MOBILE6 Tier 0 LDV BERs proposed at the October 1997 MOBILE6 workshop. Because ARB's US06 standards are established at 4K miles, projection of these standards to 50K was necessary for the analysis. This was done using the appropriate CALIMFAC "with I/M" deterioration rates. NMHC and NOx emissions were estimated from the NMHC+NOx standard using a split of 0.14 NMHC / 0.86 NOx, which was the basis of EPA's NMHC+NOx US06 standard. NMHC and NOx emissions were projected separately to 50K, then recombined. The resultant 50K US06 "standards" were then ratioed with the estimated running FTP "standards" (NMHC+NOx and CO) for both EPA and ARB, with the results shown in Table B-1. The relative stringency of the EPA and ARB standards was compared using these ratios, and the Tier 1 benefits adjusted accordingly (by adjusting the "remainder" of off-cycle emissions allowed by EPA's rule, as detailed in Table B-1) to generate controlled correction factors for LEVs.

For air conditioning, only the running NOx correction factors for LEVs were developed in this manner. The relative stringency of ARB's SC03 NOx standard was compared to EPA's Tier 1 standard relative to "running FTP" standards. ARB's standards were estimated to result in slightly more relative benefit than assigned by EPA for LDV's, but substantially more for LDTs; this is because ARB's a/C standards for LDTs were purposefully more stringent than the methodology used by EPA based on a ratio of the FTP standards. The results are shown in Table B-1.

Appendix B: Methodology for Developing LEV SFTP Benefits

Table B-1: Worksheet for Developing LEV Benefits

	NMHC+NOx				CO			
	EPA Tier 1		ARB LEV		EPA Tier 1		ARB LEV	
	V/T1	T2	V/T1	T2	V/T1	T2	V/T1	T2
FTP 50K Standard	0.65	1.02	0.275	0.50	3.4	4.4	3.4	4.4
Estimated "Running" FTP 50K Std	0.42	0.66	0.18	0.33	2.2	2.9	2.2	2.9
US06								
4K Standard			0.14	0.26			8.0	10.5
Estimated 50K Standard	0.58	0.91	0.20	0.35	9.0	11.6	9.3	12.1
Increase, US06 vs. Run FTP (%)	37	37	13	8	307	306	320	323
Delta Increase (D), ARB vs. EPA (%)			-66	-78			4	6
EPA SFTP Benefit (%: NMHC/NOx)	88/78	88/78			72	72		
EPA "Remainder" (100% - Benefit)	12/22	12/22			28	28		
ARB "Remainder"(D applied to EPA Rem)			4/7	3/5			29	30
ARB Benefit (100% - ARB Remainder)			96/93	97/95			71	70
Air Conditioning								
4K Standard			0.20	0.27	**Methodology Not Applied**			
Estimated 50K Standard	0.67	1.05	0.26	0.37				
Increase, US06 vs. Run FTP (%)	59	58	46	14				
Delta Increase (D), ARB vs. EPA (%)			-21	-75				
EPA SFTP Benefit (%: NOx Only)	50	50						
EPA "Remainder" (100% - Benefit)	50	50						
ARB "Remainder"(D applied to EPA Rem)			39	12				
ARB Benefit (100% - ARB Remainder)			61	88				

Appendix C: Worksheets for Developing Modified Age Distributions

Table C-1: LDV

Column:	A	B	C	D	E	F	G	H
Vehicle Age	MOBILE5b Annual Mileage (10K miles)	ORNL Survival Rate	A*B	Modified Travel Fraction (C / ∑C)	MOBILE5b Travel Fraction	Travel Fraction Ratio (D / E)	MOBILE5b Age Distribution	Modified Age Distribution (F*G, normalized)
1	1.4390	1.000	1.4390	0.099	0.068	n/a	0.049	0.049
2	1.4196	0.995	1.4125	0.097	0.107	0.901	0.079	0.071
3	1.3428	0.987	1.3253	0.091	0.107	0.850	0.083	0.070
4	1.2701	0.977	1.2409	0.085	0.100	0.852	0.082	0.069
5	1.2016	0.963	1.1571	0.079	0.097	0.820	0.084	0.068
6	1.1366	0.944	1.0730	0.073	0.088	0.833	0.081	0.067
7	1.0752	0.920	0.9892	0.068	0.079	0.854	0.077	0.065
8	1.0170	0.890	0.9051	0.062	0.055	1.136	0.056	0.063
9	0.9620	0.853	0.8206	0.056	0.046	1.220	0.050	0.061
10	0.9100	0.807	0.7344	0.050	0.044	1.131	0.051	0.057
11	0.8608	0.754	0.6490	0.044	0.041	1.078	0.050	0.054
12	0.8142	0.692	0.5634	0.039	0.042	0.916	0.054	0.049
13	0.7702	0.625	0.4814	0.033	0.035	0.951	0.047	0.044
14	0.7286	0.554	0.4036	0.028	0.026	1.071	0.037	0.039
15	0.6892	0.481	0.3315	0.023	0.016	1.433	0.024	0.034
16	0.6519	0.409	0.2666	0.018	0.012	1.539	0.019	0.029
17	0.6167	0.341	0.2103	0.014	0.008	1.742	0.014	0.024
18	0.5833	0.278	0.1622	0.011	0.008	1.325	0.015	0.020
19	0.5518	0.223	0.1231	0.008	0.006	1.450	0.011	0.016
20	0.5220	0.176	0.0919	0.006	0.004	1.573	0.008	0.013
21	0.4938	0.137	0.0677	0.005	0.003	1.633	0.006	0.010
22	0.4671	0.104	0.0486	0.003	0.002	1.489	0.005	0.007
23	0.4418	0.078	0.0345	0.002	0.002	1.396	0.004	0.006
24	0.4180	0.058	0.0242	0.002	0.001	1.377	0.003	0.004
25+	0.3953	0.132	0.0522	0.004	0.004	0.944	0.010	0.009

Appendix C: Worksheets for Developing Modified Age Distributions

Table C-2: MOBLDT1

Column:	A	B	C	D	E	F	G	H
Vehicle Age	**MOBILE5b Annual Mileage (10K miles)**	**ORNL Survival Rate**	**A*B**	**Modified Travel Fraction (C / ∑C)**	**MOBILE5b Travel Fraction**	**Travel Fraction Ratio (D / E)**	**MOBILE5b Age Distribution**	**Modified Age Distribution (F*G, normalized)**
1	1.5442	1.000	1.5442	0.090	0.092	0.984	0.063	0.055
2	1.5209	0.998	1.5179	0.089	0.120	0.736	0.084	0.054
3	1.4289	0.994	1.4203	0.083	0.113	0.733	0.084	0.054
4	1.3425	0.988	1.3264	0.077	0.106	0.729	0.084	0.053
5	1.2613	0.979	1.2348	0.072	0.100	0.722	0.084	0.053
6	1.1850	0.967	1.1459	0.067	0.077	0.868	0.069	0.052
7	1.1134	0.948	1.0555	0.062	0.062	0.996	0.059	0.051
8	1.0461	0.924	0.9666	0.056	0.043	1.301	0.044	0.050
9	0.9828	0.892	0.8767	0.051	0.033	1.535	0.036	0.048
10	0.9234	0.852	0.7867	0.046	0.027	1.703	0.031	0.046
11	0.8676	0.806	0.6993	0.041	0.025	1.665	0.030	0.043
12	0.8151	0.755	0.6154	0.036	0.041	0.883	0.053	0.041
13	0.7659	0.702	0.5377	0.031	0.034	0.926	0.047	0.038
14	0.7195	0.649	0.4670	0.027	0.031	0.874	0.046	0.035
15	0.6760	0.597	0.4036	0.024	0.023	1.028	0.036	0.032
16	0.6352	0.548	0.3481	0.020	0.017	1.213	0.028	0.030
17	0.5968	0.502	0.2996	0.017	0.010	1.830	0.017	0.027
18	0.5607	0.459	0.2574	0.015	0.012	1.293	0.022	0.025
19	0.5267	0.419	0.2207	0.013	0.008	1.527	0.017	0.023
20	0.4949	0.383	0.1895	0.011	0.007	1.695	0.014	0.021
21	0.4650	0.349	0.1623	0.009	0.004	2.403	0.009	0.019
22	0.4369	0.319	0.1392	0.008	0.003	2.467	0.008	0.017
23	0.4105	0.290	0.1190	0.007	0.003	2.246	0.008	0.016
24	0.3857	0.265	0.1022	0.006	0.002	3.284	0.005	0.014
25+	0.3623	1.942	0.7036	0.041	0.009	4.813	0.025	0.105

Appendix C: Worksheets for Developing Modified Age Distributions

Table C-3: MOBLDT2

Column:	A	B	C	D	E	F	G	H
Vehicle Age	MOBILE5b Annual Mileage (10K miles)	ORNL Survival Rate	A*B	Modified Travel Fraction (C / ∑C)	MOBILE5b Travel Fraction	Travel Fraction Ratio (D / E)	MOBILE5b Age Distribution	Modified Age Distribution (F*G, normalized)
1	1.4779	1.000	1.4779	0.074	0.070	1.065	0.054	0.021
2	1.4649	0.998	1.4620	0.073	0.092	0.797	0.072	0.056
3	1.4134	0.994	1.4049	0.070	0.089	0.794	0.072	0.056
4	1.3637	0.988	1.3473	0.068	0.086	0.789	0.072	0.055
5	1.3159	0.979	1.2883	0.065	0.083	0.782	0.072	0.055
6	1.2697	0.967	1.2278	0.062	0.058	1.069	0.052	0.054
7	1.2250	0.948	1.1613	0.058	0.053	1.090	0.050	0.053
8	1.1819	0.924	1.0921	0.055	0.035	1.562	0.034	0.052
9	1.1404	0.892	1.0172	0.051	0.054	0.950	0.054	0.050
10	1.1004	0.852	0.9375	0.047	0.030	1.580	0.031	0.048
11	1.0617	0.806	0.8557	0.043	0.026	1.655	0.028	0.045
12	1.0244	0.755	0.7734	0.039	0.071	0.543	0.080	0.042
13	0.9884	0.702	0.6939	0.035	0.072	0.480	0.084	0.039
14	0.9537	0.649	0.6190	0.031	0.041	0.761	0.049	0.036
15	0.9202	0.597	0.5494	0.028	0.031	0.880	0.039	0.033
16	0.8878	0.548	0.4865	0.024	0.023	1.050	0.030	0.031
17	0.8566	0.502	0.4300	0.022	0.013	1.603	0.018	0.028
18	0.8266	0.459	0.3794	0.019	0.017	1.147	0.023	0.026
19	0.7975	0.419	0.3342	0.017	0.013	1.338	0.018	0.023
20	0.7695	0.383	0.2947	0.015	0.010	1.468	0.015	0.021
21	0.7424	0.349	0.2591	0.013	0.006	2.229	0.009	0.019
22	0.7164	0.319	0.2282	0.011	0.005	2.289	0.008	0.018
23	0.6912	0.290	0.2004	0.010	0.005	1.853	0.009	0.016
24	0.6669	0.265	0.1767	0.009	0.003	2.539	0.006	0.015
25+	0.6435	1.942	1.2497	0.063	0.015	4.294	0.026	0.108

Appendix D: Results

Table D-1: Northeast (OTR NLEV, I/M, RFG)

Pollutant	Model	Calender Year	Emission Rate (Grams/Mile)								
			LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All
NOx	Modified MOBILE5b	**2000**	1.27	1.56	2.16	4.64	1.32	1.51	10.34	0.82	**2.26**
		2005	0.84	1.22	1.60	3.95	1.05	1.32	7.61	0.82	**1.68**
		2007	0.72	1.18	1.56	3.55	1.00	1.21	6.56	0.82	**1.52**
		2010	0.57	0.95	1.20	3.15	1.00	1.15	5.32	0.82	**1.23**
		2015	0.44	0.82	1.01	2.54	1.01	1.15	4.19	0.82	**1.02**
		2020	0.40	0.71	0.75	2.12	1.02	1.17	3.67	0.82	**0.87**
	MOBILE5b	**2000**	0.95	1.09	1.61	4.78	1.23	1.34	10.34	0.82	**1.80**
		2005	0.60	0.75	1.37	4.17	1.03	1.15	7.61	0.82	**1.34**
		2007	0.49	0.64	1.32	3.78	0.99	1.13	6.56	0.82	**1.17**
		2010	0.38	0.54	1.25	3.39	0.99	1.12	5.32	0.82	**0.98**
		2015	0.30	0.43	1.22	2.78	1.00	1.13	4.19	0.82	**0.82**
		2020	0.27	0.40	1.21	2.37	1.00	1.14	3.67	0.82	**0.75**
NMHC	Modified MOBILE5b	**2000**	1.02	1.70	2.27	4.40	0.55	0.78	1.80	4.51	**1.53**
		2005	0.56	0.87	1.20	3.22	0.42	0.67	1.52	4.51	**0.92**
		2007	0.44	0.70	1.00	2.95	0.41	0.61	1.27	4.51	**0.76**
		2010	0.32	0.47	0.69	2.33	0.41	0.58	0.97	4.51	**0.56**
		2015	0.23	0.35	0.57	2.01	0.43	0.59	0.66	4.51	**0.44**
		2020	0.20	0.27	0.47	1.71	0.43	0.62	0.49	4.51	**0.36**
	MOBILE5b	**2000**	0.89	1.16	1.64	4.45	0.50	0.67	1.80	4.51	**1.20**
		2005	0.48	0.65	1.15	3.30	0.41	0.56	1.52	4.51	**0.76**
		2007	0.39	0.52	1.04	3.03	0.40	0.55	1.27	4.51	**0.64**
		2010	0.29	0.39	0.90	2.40	0.40	0.55	0.97	4.51	**0.50**
		2015	0.22	0.28	0.82	2.09	0.41	0.56	0.66	4.51	**0.41**
		2020	0.21	0.24	0.76	1.79	0.42	0.58	0.49	4.51	**0.36**
CO	Modified MOBILE5b	**2000**	11.90	15.91	24.18	40.68	1.30	1.48	9.08	17.50	**15.12**
		2005	6.96	8.48	14.24	21.65	1.14	1.35	8.87	17.50	**9.07**
		2007	5.72	7.63	13.39	19.37	1.12	1.30	8.83	17.50	**8.12**
		2010	4.24	5.17	9.74	12.52	1.13	1.27	8.81	17.50	**6.03**
		2015	3.02	3.72	7.88	12.12	1.15	1.28	8.80	17.50	**4.81**
		2020	2.59	2.56	5.25	12.12	1.15	1.30	8.80	17.50	**3.85**
	MOBILE5b	**2000**	5.80	8.02	12.54	41.39	1.24	1.36	9.08	17.50	**8.20**
		2005	3.47	5.10	10.61	22.62	1.13	1.25	8.87	17.50	**5.49**
		2007	3.02	4.47	10.71	20.39	1.11	1.24	8.83	17.50	**5.05**
		2010	2.71	3.80	10.68	13.59	1.12	1.24	8.81	17.50	**4.53**
		2015	2.57	3.38	10.72	13.20	1.13	1.25	8.80	17.50	**4.38**
		2020	2.52	3.22	10.83	13.20	1.14	1.27	8.80	17.50	**4.34**

Appendix D: Results

Table D-2: Chicago (Non-OTR NLEV, I/M, RFG)

Pollutant	Model	Calender Year	Emission Rate (Grams/Mile)								
			LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All
NOx	Modified MOBILE5b	2000	1.28	1.54	2.16	4.64	1.32	1.51	10.34	0.82	**2.26**
		2005	0.85	1.20	1.60	3.95	1.05	1.32	7.61	0.82	**1.68**
		2007	0.73	1.17	1.56	3.55	1.00	1.21	6.56	0.82	**1.52**
		2010	0.58	0.94	1.20	3.15	1.00	1.15	5.32	0.82	**1.24**
		2015	0.45	0.82	1.01	2.54	1.01	1.15	4.19	0.82	**1.02**
		2020	0.40	0.71	0.75	2.12	1.02	1.17	3.67	0.82	**0.87**
	MOBILE5b	2000	0.96	1.11	1.61	4.78	1.23	1.34	10.34	0.82	**1.81**
		2005	0.61	0.77	1.37	4.17	1.03	1.15	7.61	0.82	**1.35**
		2007	0.50	0.66	1.32	3.78	0.99	1.13	6.56	0.82	**1.18**
		2010	0.39	0.55	1.25	3.39	0.99	1.12	5.32	0.82	**0.99**
		2015	0.30	0.44	1.22	2.78	1.00	1.13	4.19	0.82	**0.82**
		2020	0.27	0.40	1.21	2.37	1.00	1.14	3.67	0.82	**0.75**
NMHC	Modified MOBILE5b	2000	1.05	1.72	2.27	4.40	0.55	0.78	1.80	4.51	**1.55**
		2005	0.58	0.90	1.20	3.22	0.42	0.67	1.52	4.51	**0.93**
		2007	0.46	0.72	1.00	2.95	0.41	0.61	1.27	4.51	**0.78**
		2010	0.33	0.48	0.69	2.33	0.41	0.58	0.97	4.51	**0.57**
		2015	0.24	0.36	0.57	2.01	0.43	0.59	0.66	4.51	**0.44**
		2020	0.21	0.28	0.47	1.71	0.43	0.62	0.49	4.51	**0.36**
	MOBILE5b	2000	0.91	1.18	1.64	4.45	0.50	0.67	1.80	4.51	**1.22**
		2005	0.51	0.67	1.15	3.30	0.41	0.56	1.52	4.51	**0.78**
		2007	0.40	0.54	1.04	3.03	0.40	0.55	1.27	4.51	**0.66**
		2010	0.30	0.40	0.90	2.40	0.40	0.55	0.97	4.51	**0.52**
		2015	0.23	0.29	0.82	2.09	0.41	0.56	0.66	4.51	**0.41**
		2020	0.21	0.24	0.76	1.79	0.42	0.58	0.49	4.51	**0.36**
CO	Modified MOBILE5b	2000	12.03	16.04	24.18	40.68	1.30	1.48	9.08	17.50	**15.21**
		2005	7.01	8.61	14.24	21.65	1.14	1.35	8.87	17.50	**9.13**
		2007	5.75	7.74	13.39	19.37	1.12	1.30	8.83	17.50	**8.17**
		2010	4.24	5.26	9.74	12.52	1.13	1.27	8.81	17.50	**6.06**
		2015	3.02	3.76	7.88	12.12	1.15	1.28	8.80	17.50	**4.82**
		2020	2.59	2.59	5.25	12.12	1.15	1.30	8.80	17.50	**3.86**
	MOBILE5b	2000	5.83	8.00	12.54	41.39	1.24	1.36	9.08	17.50	**8.21**
		2005	3.46	5.07	10.61	22.62	1.13	1.25	8.87	17.50	**5.48**
		2007	2.99	4.45	10.71	20.39	1.11	1.24	8.83	17.50	**5.03**
		2010	2.68	3.77	10.68	13.59	1.12	1.24	8.81	17.50	**4.51**
		2015	2.55	3.37	10.72	13.20	1.13	1.25	8.80	17.50	**4.37**
		2020	2.51	3.22	10.83	13.20	1.14	1.27	8.80	17.50	**4.34**

Appendix D: Results

Table D-3: Atlanta (Non-OTR NLEV, I/M, No RFG)

Pollutant	Model	Calender Year	Emission Rate (Grams/Mile)								
			LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All
NOx	Modified MOBILE5b	2000	1.37	1.62	2.25	4.69	1.32	1.51	10.34	0.82	**2.34**
		2005	0.94	1.31	1.68	4.01	1.05	1.32	7.61	0.82	**1.76**
		2007	0.82	1.28	1.64	3.61	1.00	1.21	6.56	0.82	**1.61**
		2010	0.66	1.07	1.27	3.20	1.00	1.15	5.32	0.82	**1.32**
		2015	0.54	0.95	1.08	2.58	1.01	1.15	4.19	0.82	**1.11**
		2020	0.49	0.84	0.80	2.16	1.02	1.17	3.67	0.82	**0.96**
	MOBILE5b	2000	1.03	1.17	1.69	4.83	1.23	1.34	10.34	0.82	**1.87**
		2005	0.66	0.82	1.45	4.22	1.03	1.15	7.61	0.82	**1.40**
		2007	0.54	0.70	1.40	3.84	0.99	1.13	6.56	0.82	**1.22**
		2010	0.42	0.59	1.33	3.45	0.99	1.12	5.32	0.82	**1.03**
		2015	0.32	0.47	1.29	2.83	1.00	1.13	4.19	0.82	**0.85**
		2020	0.29	0.43	1.29	2.41	1.00	1.14	3.67	0.82	**0.77**
NMHC	Modified MOBILE5b	2000	1.55	2.29	2.97	6.30	0.55	0.78	1.80	5.91	**2.10**
		2005	0.89	1.25	1.65	4.79	0.42	0.67	1.52	5.91	**1.30**
		2007	0.72	1.01	1.36	4.43	0.41	0.61	1.27	5.91	**1.08**
		2010	0.54	0.69	0.94	3.60	0.41	0.58	0.97	5.91	**0.81**
		2015	0.41	0.53	0.78	3.16	0.43	0.59	0.66	5.91	**0.64**
		2020	0.36	0.42	0.65	2.78	0.43	0.62	0.49	5.91	**0.54**
	MOBILE5b	2000	1.36	1.57	2.15	6.36	0.50	0.67	1.80	5.91	**1.68**
		2005	0.78	0.91	1.53	4.87	0.41	0.56	1.52	5.91	**1.08**
		2007	0.63	0.74	1.39	4.52	0.40	0.55	1.27	5.91	**0.92**
		2010	0.48	0.57	1.20	3.69	0.40	0.55	0.97	5.91	**0.73**
		2015	0.38	0.42	1.09	3.25	0.41	0.56	0.66	5.91	**0.60**
		2020	0.35	0.36	1.02	2.87	0.42	0.58	0.49	5.91	**0.53**
CO	Modified MOBILE5b	2000	15.27	20.31	30.24	49.66	1.30	1.48	9.08	20.52	**18.98**
		2005	8.85	11.08	18.46	27.60	1.14	1.35	8.87	20.52	**11.47**
		2007	7.23	9.97	17.35	24.99	1.12	1.30	8.83	20.52	**10.25**
		2010	5.33	6.62	12.32	17.11	1.13	1.27	8.81	20.52	**7.49**
		2015	3.78	4.72	9.88	16.63	1.15	1.28	8.80	20.52	**5.91**
		2020	3.23	3.19	6.40	16.62	1.15	1.30	8.80	20.52	**4.65**
	MOBILE5b	2000	7.21	10.01	15.81	50.62	1.24	1.36	9.08	20.52	**10.03**
		2005	4.20	6.27	13.41	28.93	1.13	1.25	8.87	20.52	**6.61**
		2007	3.61	5.47	13.53	26.40	1.11	1.24	8.83	20.52	**6.05**
		2010	3.24	4.59	13.45	18.58	1.12	1.24	8.81	20.52	**5.42**
		2015	3.15	4.15	13.50	18.11	1.13	1.25	8.80	20.52	**5.30**
		2020	3.14	4.00	13.65	18.10	1.14	1.27	8.80	20.52	**5.29**

Appendix D: Results

Table D-4: Attainment (Non-OTR NLEV, No I/M, No RFG)

Pollutant	Model	Calender Year	Emission Rate (Grams/Mile)								
			LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC	All
NOx	Modified MOBILE5b	2000	1.78	2.25	3.01	4.83	1.32	1.51	10.34	0.82	**2.80**
		2005	1.19	1.77	2.26	4.22	1.05	1.32	7.61	0.82	**2.10**
		2007	1.02	1.69	2.14	3.84	1.00	1.21	6.56	0.82	**1.90**
		2010	0.83	1.52	1.85	3.45	1.00	1.15	5.32	0.82	**1.63**
		2015	0.65	1.27	1.42	2.83	1.01	1.15	4.19	0.82	**1.32**
		2020	0.59	1.13	1.11	2.41	1.02	1.17	3.67	0.82	**1.15**
	MOBILE5b	2000	1.43	1.64	2.24	4.83	1.23	1.34	10.34	0.82	**2.25**
		2005	1.29	1.48	2.14	4.22	1.03	1.15	7.61	0.82	**1.96**
		2007	1.25	1.44	2.12	3.84	0.99	1.13	6.56	0.82	**1.85**
		2010	1.22	1.41	2.11	3.45	0.99	1.12	5.32	0.82	**1.73**
		2015	1.19	1.37	2.06	2.83	1.00	1.13	4.19	0.82	**1.61**
		2020	1.19	1.36	2.05	2.41	1.00	1.14	3.67	0.82	**1.55**
NMHC	Modified MOBILE5b	2000	2.30	3.19	4.09	6.36	0.55	0.78	1.80	5.91	**2.85**
		2005	1.52	2.05	2.69	4.87	0.42	0.67	1.52	5.91	**1.96**
		2007	1.30	1.87	2.52	4.52	0.41	0.61	1.27	5.91	**1.76**
		2010	1.05	1.52	2.07	3.69	0.41	0.58	0.97	5.91	**1.45**
		2015	0.84	1.25	1.77	3.25	0.43	0.59	0.66	5.91	**1.21**
		2020	0.77	1.10	1.60	2.87	0.43	0.62	0.49	5.91	**1.08**
	MOBILE5b	2000	2.28	2.66	3.52	6.36	0.50	0.67	1.80	5.91	**2.57**
		2005	1.89	2.20	3.11	4.87	0.41	0.56	1.52	5.91	**2.14**
		2007	1.79	2.11	3.02	4.52	0.40	0.55	1.27	5.91	**2.02**
		2010	1.68	2.00	2.87	3.69	0.40	0.55	0.97	5.91	**1.87**
		2015	1.60	1.88	2.74	3.25	0.41	0.56	0.66	5.91	**1.75**
		2020	1.58	1.84	2.66	2.87	0.42	0.58	0.49	5.91	**1.69**
CO	Modified MOBILE5b	2000	24.76	29.81	41.58	50.62	1.30	1.48	9.08	20.52	**27.62**
		2005	14.68	17.66	26.14	28.93	1.14	1.35	8.87	20.52	**17.13**
		2007	12.04	16.88	25.96	26.40	1.12	1.30	8.83	20.52	**15.72**
		2010	9.05	12.36	19.43	18.58	1.13	1.27	8.81	20.52	**11.97**
		2015	6.59	8.78	14.19	18.11	1.15	1.28	8.80	20.52	**9.08**
		2020	5.78	6.48	11.05	18.10	1.15	1.30	8.80	20.52	**7.53**
	MOBILE5b	2000	15.61	19.25	26.63	50.62	1.24	1.36	9.08	20.52	**17.89**
		2005	14.19	16.97	23.77	28.93	1.13	1.25	8.87	20.52	**15.61**
		2007	13.90	16.78	23.71	26.40	1.11	1.24	8.83	20.52	**15.32**
		2010	13.65	16.68	23.79	18.58	1.12	1.24	8.81	20.52	**14.90**
		2015	13.43	16.47	23.57	18.11	1.13	1.25	8.80	20.52	**14.68**
		2020	13.39	16.40	23.53	18.10	1.14	1.27	8.80	20.52	**14.63**